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Stereoscopic Phototopographic Mapping*

CLAUDE H. BIRDSEYE

INTRODUCTION

The Geological Survey in the United States Department of the Interior is the official topographic mapping agency of the Federal Government. It is therefore intensely interested in and is constantly investigating all mapping methods and instruments that hold out any promise of increasing speed or accuracy or of reducing costs in the preparation of standard contour maps. From the beginning of experiments in mapping with the aid of the camera, the Survey has participated in the development of methods by which photographs taken either from the ground or from the air can be effectively utilized in map work, as carried on in the United States and its possessions. It has, of course, followed closely European and American development of instruments and methods, has acquired some of the more promising of these instruments, has redesigned certain features of them, and has improved the methods of their application.

HISTORY OF USE OF PHOTOGRAPHY IN MAPPING

The greatest advance of the past twenty-five years in map making is undoubtedly the application of aerial photography to the preparation of planimetric and topographic contour maps. The use of photography as an aid in the preparation of topographic maps was forecast a century ago, when

* Presidential address delivered before the Association of American Geographers at Chicago, Illinois, December 1939. Published by permission of the Director, Geological Survey, United States Department of the Interior.

the discoveries made by Niepce and Daguerre[1] in 1839 were presented to the French Chamber of Deputies.

The credit for the first practical work in adapting the camera to surveying probably belongs to Col. A. Laussedat, who began his work in 1849 under the Engineer Corps of the French Army and carried it through many years of great activity. The accounts of his progress published from year to year established him at the head of topographic engineers in the use of photography, and he is now known as the father of photogrammetry. Much of his material on photography is now available in convenient form for the use of others.[2]

The development of the various uses of photography in mapping is briefly outlined as follows:

Ground Surveys

By phototheodolite.—The use of landscape perspectives for a geometrically true representation of the terrain in horizontal plan was first realized by combination of the theodolite and camera, either in a composite instrument known as a phototheodolite or by a camera and a theodolite used separately over the same station. The first successful use of a phototheodolite in mapping was by Laussedat, who, at the Paris Exposition of 1867, exhibited the first known phototheodolite, and a plan of Paris based on his photographic surveys, which compared favorably with plans made earlier by ground instrumental methods.

Laussedat and his associates were frequently called on to make photographic surveys apart from their regular military duties, and scientists and engineers of other countries, particularly Germany, Austria, Switzerland, Italy, and Canada, did much to popularize and improve this method of surveying. Among the best known of these pioneers were Meydenbaur, Jordan, Finsterwalder, and Pulfrich of Germany; Koristka, Pollack, and Scheimpflug of Austria; Simon of Switzerland; Porro and Paganini of Italy; and Deville of Canada.

Early work in ground photogrammetry in western Canada was carried out by means of separate instruments, a theodolite being used for control and a camera mounted on the same tripod for the photographic work. The same type of equipment was employed in the topographic survey of the area adjacent to the Alaska-Canada boundary line. These instruments were first used in Canada in 1888 under the direction of Capt. E. Deville,

[1] Flemer, J. A.: *Phototopographic Methods and Instruments,* p. IV, John Wiley & Sons, New York, 1906.

[2] Laussedat, Aime: *Recherches sur les instruments, les methodes et le dessin topographiques,* Paris, Gauthier-Villars, pt. 1, 1901; pt. 2, 1903.

Surveyor General of Dominion Lands. A single photographic surveying party, composed of J. J. McArthur and three assistants, surveyed in that year about 500 square miles in the Canadian Rockies, with resulting maps on the scale 1 : 20,000 with a contour interval of 100 feet. Deville's book,[3] entitled *Photographic Surveying,* is perhaps the first treatise in English on this subject.

Instrument makers, such as Carl Zeiss and Hyde of Germany, Wild of Switzerland, and others, now make precise phototheodolites in composite instruments that measure accurately the required horizontal angles both for control and for photographic recording. Use of these instruments is now restricted largely to mountainous terrain, surveys of other areas being accomplished by use of aerial photography. Only one of these instruments is known to be in the United States. This was used first in the survey of the site of Boulder Dam, resulting in maps on a scale of 50 feet to the inch with 5-foot contours, and later in the survey of the dam site at San Gabriel, Calif., resulting in maps on a scale of 30 feet to the inch with 2½- and 5-foot contours. The Geological Survey experimented with instruments of this type in 1921, but found the method applicable only to the relatively small area of high-mountain terrain in the United States.

By panoramic camera.—Soon after Laussedat made his first experimental surveys with ground cameras, French and Italian engineers began experiments with the panoramic principle, photographing the entire horizon by one or more exposures from a ground station. Porro apparently developed in 1858 the first instrument of this type, which was fitted with sighting telescope, compass, and level and which recorded the photographs on a strip of sensitized paper on the surface of a cylinder. In the same year Chevallier developed a photographic plane table (Planchette photographique) which recorded the entire horizon on a horizontal plate, the light rays being turned at right angles by means of a prism as the sighting device was rotated. Available records do not indicate that these and other early devices were used in topographic surveys, but in 1884 Moessard developed and used the "cylindrographe" for this purpose. Moessard's instrument was equipped with a sighting device which rotated the lens in a horizontal plane and exposed a strip of film wound on a cylinder. It seems to have been well conceived but did not find much favor among topographic engineers of France, probably because the films then available were much inferior to those procurable at the present time.

The most successful ground photographic surveys accomplished in the

[3] Deville, E.: *Photographic Surveying,* 232 pp., Ottawa, Government Printing Bureau, 1895.

United States were made by the use of the panoramic camera (see pp. 5–7).

Aerial Photography

From kites.—The first aerial photographs were probably taken from kites. As early as 1858 Laussedat experimented with a plate camera supported by a string of kites ("cerf-volant" in French, "drachen" in German), but about 1860 he apparently abandoned his experimental work with aerial photography and confined his experiments to ground photography with a phototheodolite. Others, particularly Capt. Theodor Scheimpflug, of the Austrian army, continued the experiments with kites but soon dropped them in favor of photography from captive balloons and later from dirigible balloons.

From captive balloons.—Laussedat probably also took the first photographs from captive balloons. As early as 1858 he experimented with a plate camera supported by a balloon. His principle reason for abandoning his experimental work with both kites and captive balloons seems to have been the difficulty of taking a sufficient number of photographs from one station to cover all of the area that the outlook commanded. Scheimpflug apparently solved this difficulty in about 1900 by his development of the multiple-lens camera, with seven oblique lenses grouped around a central vertical lens, which afforded an extremely wide-angle composite photograph. Scheimpflug also developed the stereoscopic use of two overlapping composite photographs taken from the balloon in two adjacent positions.

The first use in the United States of photographs taken from a captive balloon was by James Fairman, who on August 2, 1887, was granted the first United States patent on aerial photography, No. 367,610, entitled "Apparatus for aerial photography," designed to use a camera, attached to a balloon or a kite, with shutter controlled by a clock movement. C. B. Adams was granted, on December 12, 1893, a United States patent No. 510,758, entitled "Method of Photogrammetry," designed to use a camera supported at two positions of a captive balloon so as to provide two aerial photographs of the same terrain and to determine both horizontal and vertical positions of the ground points. So far as is known, neither of these patented devices was ever put to practical use.

Lieut. Dache M. Reeves,[4] Air Corps, U. S. Army, in his book entitled *Aerial Photographs,* states that "as early as 1861, the possibility of using aerial photographs in military operations was considered by the Balloon Corps of the United States Army. However, there is no record that photographs were actually used at that time."

[4] Reeves, Dache M.: *Aerial Photographs, Characteristics and Military Applications,* p. 3, The Ronald Press, New York, 1927.

From dirigible balloons.—The difficulty of making satisfactory progress in mapping terrain from photographs taken from different positions of a captive balloon naturally led to experiments with photographs from free balloons. Scheimpflug, in about 1906, was apparently the first to make topographic maps successfully by this method. The chief difficulty with free balloons was the dependence on wind to direct the line of flight, therefore, soon after dirigible balloons were developed much more successful aerial photographs were obtained, and the art developed rapidly in Europe. Probably the most successful of these developments were photographs taken from the Graf Zeppelin in 1931 in its Arctic expedition and in its flight across Alaska.

From airplanes.—Available records show that the first known photograph taken from an airplane was a motion picture taken by Wilbur Wright in a flight over Centocelli, Italy, on April 24, 1909. Wright's motion picture, however, was not taken for mapping purposes. The earliest record of photographs actually taken and used for mapping is in a paper by Capt. Cesare Tardivo[5] presented on September 25, 1913, at the meeting of the International Society of Photogrammetry held in Vienna, and showing a mosaic on the scale 1:4,000 of the city of Bengasi, Italy.

HISTORY OF USE OF PHOTOGRAMMETRY IN THE UNITED STATES

Early work by the Coast and Geodetic Survey.—The only use of the camera in surveys in the United States prior to the beginning of the Geological Survey's work in Alaska had been in certain surveys carried out by officers of the United States Coast and Geodetic Survey for the International Boundary Commission in connection with the survey and location of the boundary between the United States and Canada, in a survey of the Pribilof Islands, and in a few other surveys of less importance.

Use of panoramic cameras by the U. S. Geological Survey.—Photo graphs taken from the ground were first employed in topographic mapping by the Geological Survey in 1904, when two members of its staff, C. W. Wright and F. E. Wright, used a panoramic camera in topographic contour surveying in Alaska.

The panoramic cameras used by the Wrights were improvised from commercial instruments by fitting level bubbles on the camera boxes and arranging internal scales that formed shadowgraphs upon the negatives. Although these cameras were not constructed primarily for the purpose of surveying, satisfactory results were obtained with them.

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[5] Tardivo, Cesare: "Topofotografia aerea," *Internat. Archiv fur Photogrammetrie*, 4. Band, 1913–14, pp. 180–192, pl. 6, Wien and Leipzig, 1914.

In 1907 C. W. Wright had a new camera made according to specifications which he had drawn up, but it did not become available for use that season, and soon afterward this work was interrupted by his transfer to another field. Little was then done with the panoramic camera until 1910, when James W. Bagley, one of the topographic engineers of the Geological Survey's staff in Alaska, had an opportunity to use it to a limited extent. His experience at that time was convincing as to the merit of the panoramic camera, and its employment in Alaska surveys steadily increased.

The panoramic camera is a box type in which the lens is revolved about a vertical axis by a spring, the rate of revolution and, in part, the exposure being regulated by detachable fans connected by gearing with the lens shaft. Roll film in 5- or 6-inch cartridges with several exposures each is placed on a circular film guide, so adjusted that when the film is in position for exposure all elements of the cylindrical surface of the film will be perpendicular to the level plane and parallel to the lens shaft. The top of the camera, being the reference plane for leveling, is fitted with leveling bubble slots at right angles to each other. Three leveling screws of the common type are used in connection with an adapter plate which will fit a plane-table tripod, thus avoiding the necessity of transporting two tripods. The horizontal field of view is 126° for each exposure, and the vertical range is from 18° to 22° above the horizon and from 26° to 30° below the horizon, depending on the width of film used. The film is usually developed in the field to check the quality of exposure and the coverage of the area to be mapped.

A photoalidade was designed in the Geological Survey for use with photographs taken by the panoramic camera. Briefly stated, its purpose is to transfer to the map the information obtained from the photographs. It is so designed that the operator may sight any image point in the photograph and determine the horizontal direction from the station point to the image point, in the same manner in which the topographer operates the telescopic alidade on a plane table in the field. A reading glass with a vertical hair, used with a sighting vane, may be said to represent the lens system in a field instrument. A radial arm represents the plotting base on an alidade, and directional lines are plotted along this arm on the map sheet. The reading glass, sighting vane, and radial arm are controlled by a mechanism of the rack-and-pinion type revolving around a point that represents both the optical center of the lens and the camera station.

In order to obtain differences of elevation for contour sketching, vertical distances of points above or below the horizon line, which appear as shadowgraphs on the print, are measured. A simple formula that uses these measured vertical distances with the corresponding map distance and

the principal distance of the photograph gives the difference of elevation. A separate office instrument known as a rotary scale has been constructed to expedite the measurement of the vertical distance.

More than 23,000 square miles of rough mountain terrain has been photographed in Alaska with the panoramic camera, and the resulting photographs have been worked up successfully in map form by means of the above-mentioned instruments.

In 1932 R. M. Wilson[6] of the Geological Survey designed a new photoalidade for use with photographs taken by the panoramic camera. It may be used also with low-oblique photographs taken with any single-lens aerial camera whose focal length is more than 4 inches but less than 14 inches. It is used with oblique photographs as large as 10 by 12 inches, which show the plane of the horizon and terrain as much as 10° above to 50° below the horizon. The instrument consists of an adjustable print holder, a telescope for reading horizontal and vertical angles, a centering microscope used to place the station point on the map sheet exactly in the vertical axis of the viewing telescope, and a straight-edge connected with the vertical axis of the telescope so that directions from the station point can be plotted on the map sheet.

Within the field of view presented by the photograph, it is possible to conduct in the office most of the operations that would be possible with an ordinary plane table and telescopic alidade in the field. Topographic features may be located by intersection and their altitude determined, provided oblique photographs of the same terrain have been taken from two or more different points of view. Thus the sketching of contours may be controlled, just as is done by using the intersection method with a plane table. The new photoalidade is particularly adaptable to reconnaissance and exploratory mapping in Alaska because of the extensive areas shown in most oblique photographs. It should be adaptable also to revision of small-scale maps in reasonably flat areas where high ridges do not conceal important features of the terrain.

Development of multiple-lens cameras.—In 1911 there came to the attention of J. W. Bagley and F. H. Moffit, of the Alaskan Branch of the Geological Survey, a memorial on the work of Theodor Scheimpflug, which described his multiple-lens camera. That camera had one vertical center lens and a circle of seven lenses set at angles around the center lens. Bagley and Moffit made a study of this arrangement of lenses and decided to attempt the construction of a multiple-lens camera. Scheimpflug's idea was to have his camera suspended from a balloon. Moffit and Bagley realized

[6] Wilson, R. M.: "A New Photoalidade," *Military Engineer,* November-December 1937, pp. 434–436.

that such an arrangement could not be carried out in Alaskan work and that their method of using photographs taken from the ground was better suited to Alaskan terrain. For that reason, they put aside their experiment temporarily.

When they returned from Alaska in 1916, Bagley found that the Army was much in need of maps along the Atlantic coast, and with the thought that rapid mapping could be done with a multiple-lens camera supported in an airplane, he and Moffit resumed their experiments. Moffit undertook the task of developing the theory and of designing and constructing a universal transformer, while Bagley, with the assistance of J. B. Mertie, devoted all his time to the development of the aerial camera itself. The aerial camera was built from the design of Bagley and Carl H. Au in Au's shop in Washington, D. C. Moffit completed the design of the transformer and supervised the work of making the patterns, machinery, and castings by commercial shops. The principal work on the castings was done in Baltimore, and the instruments were assembled and adjusted in Washington. The National Research Council allotted a small sum for the development of the first experimental cameras, and after the results obtained with them were submitted to General Black, Chief of Engineers, the Corps of Engineers in 1918 made an allotment of $75,000 for the development and construction of aerial cameras and transformers.

In 1917 Bagley was commissioned a major in the Engineer Officers Reserve Corps, and the first photographs were taken with his tri-lens camera at Langley Field in cooperation with the Air Service in the winter of 1917–18. The results of these tests served as a basis for a program to photograph several strips of country between aviation fields, for the purpose of making aeronautical maps. This work was undertaken jointly by the Corps of Engineers and the Air Service, with the Geological Survey contributing aid in a general way. Bagley was then ordered to France and continued his experimental work with the tri-lens camera in the American Expeditionary Force. The activities of the Geological Survey in this field were soon curtailed by the rapidly increasing demands of the World War.

After the War Bagley at McCook Field (now Wright Field) continued making improvements on the tri-lens camera and finally put on the fourth chamber, making the four-lens camera. As a result of experience with enlisted men as laboratory assistants, he felt the need of a fixed transformer that would require no adjustment and that could be used in connection with a definite aerial camera. On request of Bagley, Moffit made preliminary drawings for building the fixed transformers. These drawings were completed at McCook Field, and the cameras and transformers were constructed.

Later, a five-lens camera was designed and is now manufactured by the

Fairchild Aerial Camera Corporation. This is the type of multiple-lens camera now in use by the Corps of Engineers, the Marine Corps, the Hydrographic Office, the Air Corps, and the Geological Survey.

Lieut.-Commander O. S. Reading, in charge of photogrammetric work in the Coast and Geodetic Survey, designed in 1935 a new nine-lens camera[7] which was manufactured in 1936 by the Fairchild Aerial Camera Corporation. This camera carries a single roll of film 23 inches wide and 200 feet long, on which are recorded the images of all nine lenses, the optical axes of all of which are parallel and vertical. The focal length of each of the matched lenses is 8¼ inches (215 mm.), and the rays from the fields of view of the eight outside lenses are gathered by means of chromium steel mirrors coated with evaporated aluminum. The field of view of the camera is 130° square, and when each segment is transformed in place on a piece of acetate film by means of a special two-lens transformer, a 35- by 35-inch positive is obtained, which can be used in map construction. The first use of photographs taken by this camera was in compilation of planimetric base maps for hydrographic surveys of the Coast and Geodetic Survey.

Application of photogrammetry to planimetric and topographic contour mapping.—The World War focused attention on the value of aerial photography, and many of the 113 topographic engineers of the Geological Survey who served in the military forces, brought back observations that aroused intense interest in application of the method to both planimetric and topographic contour mapping. The war experience of these engineers, in fact, was largely responsible for the Survey's pioneer work in this field.

In the spring of 1920 the West Indies Surveys Division of the Geological Survey, in cooperation with the Marine Corps, began a systematic aerial photographic survey of parts of Santo Domingo and Haiti, using a tri-lens camera. In the same year the Survey made its first successful attempt to map a standard quadrangle by utilizing single-lens aerial photographs for the preparation of field sheets on which all of the planimetry was shown, but for which contours were delineated by topographers on the ground. The photographs, which covered the Schoolcraft (Michigan) quadrangle, were taken and supplied by the Air Corps. This quadrangle map was issued in 1922 and represented the first quadrangle mapping done in the United States in which aerial photography played a part. In 1923 surveys of the Reelfoot Lake quadrangle, Tennessee-Missouri-Kentucky, were completed, part of the culture and drainage being taken from aerial photographs. In 1921 Bibb County, Ga., was surveyed, and the culture and drainage were taken from aerial photographs supplied by the U. S. Army Air Corps.

[7] *News Notes*, American Society of Photogrammetry, May–June, 1935.

The estimated saving effected by the use of aerial photographs on the Schoolcraft project was about $7 per square mile, or $1,500 for the 15-minute quadrangle. The planimetry, on the field scale of 1:48,000, was furnished to the field engineers in the form of non-photographic blue lithographs on double-mounted drawing paper, to be used as planetable sheets for the delineation of the contouring by ground survey methods. The area was photographed with a single-lens camera in two half-days of flying time. At that time, office methods of compiling the planimetry were crude, and the use of single prints was somewhat expensive, but enough knowledge was gained to indicate that the use of aerial photographs would be of material value in topographic mapping, not only because of reduced field costs but also because of the greater accuracy in the resulting map.

In February 1921 a new subdivision of the Geological Survey was established in the Topographic Branch, designated as the "Section of Photographic Mapping." The function of this section was to investigate the probable usefulness of aerial photographs in making planimetric and topographic maps. It was first successful in the completion of planimetric base maps for use in making standard topographic contour maps and has continued in this work up to the present time.

After the Section of Photographic Mapping had gone into the production of base maps, part of its efforts were turned to the second line of investigation—stereophotography. The use of stereoscopy makes it possible to measure on the photographs themselves distances, directions, and elevations. If two photographs, covering the same area and taken with the same lens, but from a different angle, are brought into a certain position with relation to each other and then viewed stereoscopically, the effect of relief and perspective can be seen. This perception was the foundation for the development in Europe about 1904 of instruments that measure this relief and perspective. Before the World War, photographs were taken from the ground and used in stereo-comparators (stereoscopes equipped to measure rectangular coordinates and the "parallax" of objects) to construct maps from pairs of photographs with the aid of known positions and elevations. However, the procedure was very tedious and required a great deal of mathematical or graphical labor.

Instruments employing stereoscopic principles.—During and immediately after the World War several instruments were put on the market with which complete topographic maps could be constructed semiautomatically from pairs of photographs taken from the ground or the air with the help of known ground points. In these instruments the photographs were viewed stereoscopically. With an index mark called a "floating mark" in the field of view, it was possible to follow a contour line in the stereoscopic model

and to raise or lower this mark in proceeding from one elevation to another, the result of these movements being a correct delineation of the terrain in both plan and elevation.

In 1924 one of these instruments, the stereo-autograph, was imported from Germany and installed in the Survey's offices. The results of two tests made with ground photographs taken in the vicinity of Mount Washington, N. H., and in the vicinity of Alexandria, Va., showed that it was entirely possible to construct topographic maps from ground photographs if there were three or more known positions and elevations in each pair of photographs, and it was found that the accuracy of these maps was equal to or in excess of that of maps constructed by ordinary methods. However, because so many known points were necessary for each pair of photographs, and also because aerial photographs with their larger area could not be used, this instrument was not considered economical for American use.

The first commercial use of aerial photographs in making topographic maps in the United States seems to have been by a firm in Philadelphia that later became known as Brock & Weymouth. This firm designed stereoscopic mapping equipment and developed a mapping method that made use of photographs taken with a 6½- by 8½-inch plate camera. This equipment was developed to a high degree of precision and was used successfully in many contracts for private firms and several contracts for Federal agencies, the most successful of which were the topographic mapping of part of the Wabash and White Rivers in Indiana in 1929 for the Corps of Engineers, and the topographic mapping of the area around Boulder Dam in 1930 for the Reclamation Service. In both of these surveys, Brock & Weymouth established high-grade second-order horizontal and vertical control.

The Geological Survey began experimenting with the application of stereophotogrammetry to topographic contour mapping from aerial photographs in 1927, when one unit of a German stereoscopic plotting apparatus known as the aerocartograph, and using vertical or oblique single lens aerial photographs, was installed on trial. After a year of experimental work the apparatus was purchased, and became the first stereoscopic plotting instrument owned by the Federal Government. Further tests and experimentation were carried out and, in the spring of 1930, a definite production project was begun—a strip survey along the upper Columbia River in the State of Washington. This was followed in the same year by a survey of about half of Zion National Park and Bryce Canyon National Park in Utah, and in 1931 by a survey of the Lakeport quadrangle, Calif. Use of the aerocartograph requires three horizontal and vertical control points, established by terrestrial surveying, properly placed at one end of each flight strip, and two similar positions at the other end of the strip; but experience

has demonstrated that one additional elevation established by terrestrial surveying for each optical model aids in the horizontalization of the model and strengthens the plot. In 1935 the Corps of Engineers designed new plate holders for its aerocartograph to accommodate negatives for the five-lens cameras, and in 1936 it remodeled the Geological Survey's aerocartograph in the same manner, so that both instruments can be used to plot contour maps from five-lens photographs. The Los Angeles Division of Fairchild Aerial Surveys also owns an aerocartograph, but it has not been remodeled to use five-lens photographs.

In 1929, a grant from the Guggenheim fund for the Promotion of Aeronautics was made to the College of Applied Science of Syracuse University. This grant was restricted to the purchase of instrumental equipment, with the understanding that the University would provide the space and teaching staff for carrying a program of instruction in aerial photographic surveying and mapping.

Much of the equipment first purchased consisted of aerial cameras, comparators, stereocomparators, photogoniometers, rectifying cameras, and other laboratory equipment for making measurements on aerial photographic plates. During the first four years, the University concentrated its work largely on the use of solid analytic geometry in computing positions in space from the measurements taken from photographs with these instruments.

In 1936, the University purchased from this grant a Multiplex Aeroprojector and began to train students in the practical aspects of stereoscopic plotting of contour maps from vertical aerial photographs of moderate scales such as 1 : 20,000 which are being used by the Geological Survey and the Corps of Engineers. With this additional equipment and an able staff of instructors, Syracuse University should be better fitted than any other school in the United States to turn out well trained graduates in photogrammetry.

Although the aerocartograph assured the use of aerial photographs by the Geological Survey in topographic contour mapping, the cost of the equipment was very high, hence it was not until the introduction in 1935 of less complex and less costly apparatus, the multiplex aeroprojector, that the value and economy of such methods were definitely established. The Geological Survey purchased a nine-fold Zeiss aeroprojector in 1935 and several other units of this type in 1936 and 1938. The first was equipped with normal projectors, and the latest with wide-angle projectors. These instruments are being used successfully in making contour maps of parts of the Tennessee Valley area. In this work single-lens vertical aerial photographs are used, with one or more terrestrial horizontal control points provided for every third or fourth model in each flight, and one vertical

control point on each optical model. Rigid tests of the work in the Tennessee Valley indicate that large-scale contour maps of rough terrain, made by operators skilled in the use of the equipment, are in general more accurate than maps of similar areas made at comparable cost and scale by ground Survey methods with the plane-table. However, the development of these stereoscopic instruments and methods to the point of satisfactory precision, has involved time and difficulties. Wide-angle lenses have been adopted in place of the original narrow-angle lenses, and the 1935 instruments have been modified and improved with increase in rigidity and accuracy. In its present stage of development the stereoscopic equipment gives results that are highly satisfactory as to accuracy and cost, when applied to terrain of suitable relief. Even in areas of low relief, where a small contour interval is necessary, mapping by normal plane-table methods can be done at less cost if a planimetric base is first constructed from aerial photographs by means of the aerocartograph or the multiplex projector.

Aerial photographs taken with a single-lens camera with 70° field of view are being used at present in the normal multiplex projectors. This camera has a focal length of 210 millimeters (8¼ inches) and a negative size of 24 by 24 centimeters (9 by 9 inches). The photographs used with the wide-angle multiplex projectors have been taken with a similar camera with a 90° field of view, the focal length of which is 167 millimeters (6½ inches) and the negative size 24 by 24 centimeters. The Geological Survey has purchased a Zeiss-Aerotopograph model R. M. K.—P 10 wide-angle single-lens camera with a 100° field of view and a focal length of 100 millimeters (4 inches), which is being utilized for mapping rolling and mountainous areas, resulting in a material reduction in operating costs.

Another German instrument, known as the Zeiss Stereoplanigraph[8] is used in the United States by the Los Angeles Division of Fairchild Aerial Surveys, Inc. This is a larger and more expensive instrument than either the Aerocartograph or the Multiplex, and is considered by most photogrammetrists to be one of the most precise stereoscopic plotting instruments yet made.

Other well known and highly recommended stereoscopic plotting instruments are made in Switzerland and Italy, but none of them are in use in the United States. Among these is the Wild Autograph,[9] made by the

[8] Eliel, Leon T.: "The Stereoplanigraph," *News Notes,* The American Society of Photogrammetry, Nov. 1934, pp. 10–16.

Also Dr.-Ing. Luscher: "Stereoplanigraph, Modell 1938," Generalbericht der Kommission 4, Luftbildauswertung—Fünfte Internationaler Kongress fur Photogrammetrie, seite 14.

[9] See *Photogrammetric Engineering,* April–May–June, 1939, pp. 64–65.

Wild Surveying and Instruments Supply Co., at Heerbrugg, Switzerland. The Italian instruments include the Santoni Stereosimplex and the Nistri Fotocartografo, described on pages 34 and 37, respectively, of the Report of Commission 4[10] of the Fifth International Congress of Photogrammetry at Rome in 1938.

Other instruments used in photogrammetry have been developed recently in the United States by officers of the Corps of Engineers and others.

In 1934 Bagley (who, as already stated was formerly one of the topographic engineers of the Geological Survey's staff in Alaska) developed an aerial photograph calculator[11] which is a mechanical instrument designed to measure the axis and degree of tilt of aerial photographs, the height of exposure stations, and the elevation of points on the ground represented by images on the photographs. This instrument is used in the field laboratories of the United States Army Corps of Engineers, at the Engineer School, Fort Belvoir, Virginia, and at the Institute of Geographical Exploration at Harvard University.

Bagley also developed in 1934 a stereoscopic plotting machine[12] designed for use with five-lens photographs. This machine has not been put into general use by the Corps of Engineers but is being used by the Institute of Geographical Exploration.

A reconnaissance stereoscopic plotting instrument known as the stereocomparagraph[13] was developed by Capt. B. B. Talley of the Corps of Engineers. This instrument, designed to train students in stereoscopic plotting of contour maps from aerial photographs, is now being used by several Federal and private agencies and by schools teaching photogrammetry, such as the United States Military Academy, the Engineer School at Fort Belvoir, the Department of Geodesy and Engineering at Rensselaer Polytechnic Institute, and the Institute of Geographical Exploration at Harvard University.

As already stated, the Corps of Engineers redesigned its own aerocartograph and also the one belonging to the Geological Survey. It has used its aerocartograph with both vertical and multiple-lens photographs in mapping, but is now using this instrument largely for control work and the multiplex aeroprojector for contour mapping.

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[10] Generalbericht der Kommission 4, Luftbildauswertung—Fünfte Internationaler Kongress fur Photogrammetrie.

[11] For description, see U. S. Patent No. 2,053,019, September 1, 1936, entitled, "Aerial Photograph Calculator."

[12] This machine is covered by U. S. Patent No. 2,044,114, June 16, 1936, entitled "Plotting Machine and Process of Making Maps with Aerial Photographs.

[13] Described in *Photogrammetric Engineering*, July–Aug.–Sept. 1936, pp. 64–67.

The Soil Conservation Service has developed a reflecting projector[14] which is used to transfer the planimetric details from opaque photographs to the base sheet on which all of the geodetic and photographic control points have been plotted by radial triangulation. The Geological Survey and other Federal agencies have acquired instruments of this type and are using them successfully in planimetric mapping.

The American Geographical Society has developed a single-eyepiece plotter[15] which is sensitive to the nearest minute of arc and employs the principle of a real rather than a virtual index mark. Plans are being made to incorporate this principle in the construction of a general-utility stereoscopic plotting instrument for both vertical and high oblique aerial photographs.

PHOTOGRAMMETRIC METHODS NOW USED BY GEOLOGICAL SURVEY

In modern topographic mapping, aerial photographs are used as pictures of the ground, and from these photographs, directions, distances and elevations of ground features are measured. Thus, the topographer may be said to use wings to secure his basic information, because in swift, photographically equipped airplanes he can cover areas in a few hours where weeks of laborious traversing and plotting would have been required to secure the same information by the old-fashioned ground survey methods. Do not assume from this, however, that it is only necessary to photograph the ground in order to make a map. Quite the contrary, because there is a lot to do besides taking the photographs, as will be seen from the following descriptions.

The Geological Survey does not maintain its own airplanes, but the actual photography for its aerial mapping program is executed by private aerial photographic contractors and by the U. S. Army Air Corps. The Survey does, however, have a few aerial cameras and all of its own stereoscopic plotting instruments.

AERIAL CAMERAS

The most effective aerial camera used by the Geological Survey is a Zeiss Aerotopograph single lens, wide angle camera, which has a focal length of 100 mm. (about 4 ins.), an angle of view of nearly 100 degrees, and produces a negative about 7 by 7 inches in size. When loaded with the

[14] Kennedy, M. S.: "Overhead Vertical Reflecting Projector," *Photogrammetric Engineering*, January–February–March 1937, pp. 28–31.

[15] For description see *Journal of the Optical Society of America*, vol. 25, pp. 185–189. This instrument is covered by U. S. Patent No. 1,985,260 issued December 25, 1934, entitled "Stereoscopic Plotting of Contour Maps."

usual length of film, about 200 feet, there is sufficient footage for several hours flying time—about 300 exposures. Photographs taken by this particular camera are used in the Survey's wide angle Multiplex Aeroprojectors. The Survey also owns several Hugershoff short focal length cameras, photographs taken by which are used in its aerocartograph, the first stereoscopic plotting instrument owned by the United States government. One of these cameras uses a roll of film affording 300 exposures each 5 by 5 inches in size, and the others have detachable magazines holding either roll film or glass plates taking photographs 5 by 7 inches in size. Much of the photography used by the Survey is, however, taken by new precision single lens cameras owned by private contractors. These cameras take photographs 9 by 9 inches in size, with lenses having focal lengths of $6\frac{1}{2}$ or $8\frac{1}{4}$ inches.

Planning Flights

When the areas to be mapped photographically are decided upon, the cartographer lays out flight lines on base maps—lines to be followed by the navigator and pilot. Flights are usually planned so that the entire width of two fifteen-minute quadrangles can be spanned in one flight, the distance between adjacent flights being governed by the focal length of the lens and the height of the camera above ground. This means that, with a six-inch lens camera in average latitude, the plane will follow flight lines about thirty miles long, spaced about two miles apart, when flying at 12,000 feet above the ground. Each map thus prepared contains all flight instructions necessary to guide photographer and pilot in securing the desired photographic coverage—sixty per cent overlap in line of flight and thirty per cent sidelap between flights.

For the most successful results, flights are made in the middle of the day, during the winter season when the leaves are off the trees, and at altitudes varying from 5 to 20 thousand feet above the ground, depending on mapping requirements. Map specifications usually require that 85 per cent of the points tested shall have a vertical accuracy of at least one-half the contour interval of the map. To attain this accuracy, it has been found by experience that the flight altitude above average ground level should not be more than 600 times the contour interval of the map. The focal length of the camera has nothing to do with this vertical accuracy, but it does of course affect the scale of the resulting photograph, and the cartographer is required to take these two factors into account in planning the spacing of the flight lines on the flight map. For example, if the contour interval selected is 20 feet, the altitude above ground must not be more than 12,000 feet, and if the focal length of the camera is 6 inches, the scale of the photograph will be 1 : 24,000.

Photographing the Ground

The cameras are electrically operated and mounted in the airplane on a support that permits the lens to project down through the fuselage, thus clearing the bottom of the ship and giving an unobstructed view of the terrain below. The electric motor winds the negative on the pick-up spool and trips the shutter at the proper time for each exposure. Level bubbles are mounted on the frame of the camera so that the operator can keep the negative plane of the camera horizontal at each exposure, thus compensating for any irregular angle of the plane while in flight. In the ship also is mounted a view finder, known as an intervalometer, which enables the photographer to see the images of the ground and to line them up by the moving splines of the intervalometer, so as to set the camera in the proper direction and to indicate the proper moment to make the exposures, after compensating for speed and drift of the plane in the air.

Developing and Drying Film

As soon as possible after the area is photographed, the negatives are developed. A most important factor is that the film in its roll stage has an even development to insure good reproductions in the later phases of aerial photographic mapping. Perhaps the best way of doing this is by use of developing machines that wind the negative back and forth through the developing solution. Other important factors are the use of proper emulsion bases, and the proper kind of drying technique that avoids any stretching or distortion of the negative. Roll film negatives must always be developed as quickly as possible after exposure, in order to reduce shrinkage to a minimum. After development, the film is dried and left in its roll form. This is usually done on a cylindrical slatted drum, but may be done in an electric drying machine.

Contact Printing

Contact prints of each individual negative are made by the usual method for use by the geodetic engineers in identifying on the ground the images of critical points needed for ground control. Many laymen think that all that is necessary in making a map is to photograph the terrain and a map is immediately forthcoming. It is true that a rough mosaic can be made by joining together photographs by their images alone, but this is not a map, for such a mosaic has no exact scale and both horizontal and vertical ground control are necessary to make any accurate measurements on it. Nevertheless, an accurate map can be made from these photographs if proper control is available and proper technique is used. Triangulation and traverse sta-

tions and level bench marks are often available for the terrain being mapped, but these points usually cannot be identified on the photographs and usually are not properly placed for stereoscopic plotting, Therefore, the geodetic engineers must take the photographs into the field and secure the horizontal and vertical coordinates of points indicated by the photogrammetrist in the office.

Supplemental Control

This is usually done on a copy of the same flight map used by the pilot and photographer, by outlining the position of each photograph by means of a template representing in size and shape, on the scale of the map, the area included in a single photograph. By laying this template properly on the flight map that guided the photographic ship, the relative position of each photograph is discovered. This is just like laying shingles on a roof and, as shingles must be nailed down to a rigid frame work, so must the relative positions of the areas represented by each photograph and their absolute place on the map be determined. To do this, images of definite points are selected which will show clearly on the negatives and which will provide horizontal and vertical positions of four well-disposed points on optical models formed by about every fifth overlapping pair of photographs in each flight line, and one vertical position on each of the other optical models. These supplemental control points are such easily identifiable points as fence corners, lone trees, corners of buildings, clearly defined highway intersections, etc., and they are located by ground measurements from available primary triangulation stations and level bench marks. Their horizontal and vertical coordinates are then computed so that they can be plotted on the projection sheet on which the map is to be drawn.

Diapositive Printing

While photogrammetrists are planning the supplemental control, laboratory photographers are printing each negative on a positive glass plate. This is done in a reducing camera, called a diapositive printer, composed of a base, a projection lens, a diapositive plate support, a light source and a reflector. The roll film negative is supported on a glass platform, with the fiducial marks on each negative registered with extreme precision to corresponding fiducial or control marks on the supporting glass platform. When properly registered, each negative is held in position during the printing operation by a heavy glass pressure plate. The camera, or printer, is of the fixed focus type and reduces the image on the negative about four and one-half times. The printer must be set with extreme care in order to

obtain the proper dimension for the reduced image, and to maintain maximum sharpness. The reduced image is projected to a small glass plate known as a diapositive. Making these diapositive glass plates is one of the most critical operations of stereoscopic plotting. They must be made on perfectly flat glass plates coated with an emulsion having high resolving powers and made thin by slight over-exposure. Ordinary photographic methods are not satisfactory. Fine grain developers must be used and the plates handled with great care. After printing, the edges of the plates are carefully ground with an abrasive belt to remove sharp edges and to ensure proper fitting in the plate holders when the diapositives are projected. Each of these plates is stored in its individual envelope containing full information about the plate inside.

MULTIPLEX AEROPROJECTOR

The principal stereoscopic plotting instrument now in use by the Geological Survey is known as the Multiplex Aeroprojector. This instrument was first made by Zeiss Aerotopograph, a division of Carl Zeiss Works, Jena, Germany. However, the American firm of Bausch and Lomb of Rochester, N. Y., now has a license to manufacture this instrument and is making those to be used by the Geological Survey and the Corps of Engineers.

The principal of this instrument is the dichromatic projection of overlapping vertical aerial photographs in alternate complementary colors, usually red and green, and viewing through spectacles of corresponding complementary colors, the spatial model found by the fusion of the doubly projected images. This principle is commonly utilized in anaglyphs used in three dimensional illustrations in books and sometimes in three dimensional motion pictures.

The multiplex instrument is a series of small projection cameras mounted on an adjustable support. One of the small diapositive plates is adjusted in the focal plane of each projector so that its center coincides with the axis of the projector, and alternate red and green glass filters are placed in the lamp houses of alternate projectors, so that the images from the overlapping diapositive plates in adjacent projectors are projected on the drawing table in the complementary red and green colors.

All the control points are plotted on the projection sheet mounted on the drawing table and, as the successive models are projected, the operator views them with red and green spectacles and sees the three dimensional models in neutral tone. He focuses these models on a white platen on the top of a small movable tracer, in the center of which is a luminous point, technically called a floating mark, which is directly above a pencil point

which traces the position of the floating mark on the map sheet. The operator adjusts each projector for tip, tilt and swing, and raises the top of the platen on the tracer (called the tracing table) by a finger ratchet in order to set it for the proper elevation.

Plotting with Multiplex

After all of the adjustments have been made so that the projected images of all four ground control points on the first optical model fall exactly on their plotted positions on the projection sheet, the operator then moves the tracing table over the map sheet so that the floating mark follows all of the cultural features on the model—roads, trails, houses, etc.—keeping the elevation of the platen so that the floating mark always seems to touch the ground. The pencil point thus plots all of the cultural features on the map.

The next operation is to plot all the drainage features—streams, lakes and ocean shores—following the same procedure as used in plotting the cultural features, including raising or lowering the platen so that the floating mark always seems to touch the ground. The last operation is to draw the contours, which differs only from the other two operations in that once the proper elevation of a contour is set by the finger ratchet, the elevation of the platen is not disturbed, but the tracing table is forced over the model, around the ridges and up the valleys, so that the floating mark is kept always touching the ground.

Once all of the features on the optical model formed by the diapositives in the first two projectors are plotted, the operator turns off the lights on the first projector and turns on the third, forming the next model in the series, and "bridging" the control used in the first model by not disturbing the adjustment of the second projector in any way. Thus the operator continues with all of the models until the map area is covered. This completes the work of the photogrammetrist with this type of instrument.

AEROCARTOGRAPH

The Geological Survey has another type of stereoscopic plotting instrument known as the Hugershoff Aerocartograph. As previously stated, this instrument was imported from Germany in 1927 and became the first stereoscopic plotting instrument owned by the Federal government. This instrument is described in detail in a paper published by the American Society of Civil Engineers,[16] but following is a brief outline of its principles and of the differences of its operation and that of the Multiplex.

The diapositives made for the Aerocartograph are the same size as the

[16] Birdseye, C. H.: Stereo-Topographic Mapping," Paper 1843, *Transactions*, American Society of Civil Engineers, Vol. 98 (1933), pp. 771–825.

aerial negatives and hence much larger than those used in the Multiplex projectors. The method of observing the optical model formed by two overlapping photographs in the Aerocartograph is through an optical system consisting of two telescopes each having a number of lenses and prisms. Each diapositive in the Multiplex is projected directly on the drawing table, but the diapositives in the plateholders of the aerocartograph are not projected at all. Instead they are viewed stereoscopically by the operator and he guides the movements of the tracing pencils in the three coordinates of space by moving two hand wheels and a foot wheel. The operator can move a cylindrical drum under a tracing pencil, as well as moving a pencil over a stationary map. In this way two maps can be made at the same time and at different scales, one on the drum and one on the drawing table. With the Multiplex, the pencil is moved over a fixed drawing and only one map can be drawn at the same time.

The aerocartograph is very accurate, its most successful use being in completing the mapping of Zion National Park, Utah, where the contours plotted in the office joined without adjustment those mapped by an exceedingly skilled topographer in the field.

COMPLETION SURVEY

After all of the basic information has been traced from the diapositives, by either of these (or by any other) stereoscopic plotting method, it is necessary to finish the map by what is called a completion survey. This must be done in the field by ground survey methods, so as to make an accurate check of essential topographic features as well as to add such information as is not visible on the photographs. These field examiners determine city, county and state boundaries, classify roads, locate farm buildings, obtain names of streams, hills, towns and similar data, and plot all other features not obtainable from the photographs.

Thus the work of the photographer, the cartographer, the surveyor and the photogrammetrist has all been coordinated and fitted together. The final hand-drawn map is thus completed, ready for shipment to the Washington office for editing and reproduction in colors—black for cultural (man made) features, blue for water features, brown for contours, green for woodland areas, and red for road classification.

MAP REPRODUCTION

Most of the maps drawn by stereoscopic plotting instruments are reproduced by multi-color photolithography. There are of course several ways in which pencil drawings can be reproduced in colors, and the Geological Survey selects the one that seems best adapted to a particular project and

promises the quickest and cheapest results. The maps may be reproduced by engraving on copper plates, by engraving on glass, or by inking a separate drawing for each color and making a photolithographic plate for each color. A complete discussion of this subject of map reproduction would require a book, and the writer does not know of one that is complete and up to date, except a new British book entitled "Practical Photolithography," by C. Mason Willy, published by Sir Isaac Pitman and Sons, Ltd., London, in 1938. The writer, however, presented a short illustrated paper entitled "Map Reproduction" at a meeting of the American Association for the Advancement of Science at Rochester, N. Y., June 17, 1936. This paper covers briefly the three subdivisions of the subject, but was not published.[17]

The third method mentioned is perhaps used most commonly in reproducing maps plotted by the Multiplex Aeroprojector, and is described briefly as follows: The scale of pencil drawings made on the Multiplex depends partly on the height of the aerial camera above the ground, and partly on the focal length of the aerial camera. However, if the aerial photographs are on the scale previously cited, *viz.*, 1:24,000 (2,000 feet to the inch), and the map is going to be published on the scale of 1:31,680 (2 inches to the mile), the multiplex plot will usually be drawn in pencil on the scale of 1:15,840 (4 inches to the mile), and this pencil plot will usually be inked on the scale of 1:24,000. Therefore, in this example, the pencil drawing is photographed to the scale of 1:24,000 and several non-photographic blue line prints on metal mounted drawing paper are processed from the same glass negative.

These drawings are copied photographically by one of the largest map copying cameras made, taking wet plates as large as 50 by 50 inches in size. When these wet plate negatives are developed, they can be processed direct to a sensitized metal printing plate, or to a sensitized sheet of drawing paper mounted on a metal plate to prevent shrinkage or distortion.

On an extra blue line print that is not mounted on metal, the map editor carefully checks every line, elevation and symbol as a guide to the topographic draftsman, so that the final published map will come up to Geological Survey standards of accuracy, clarity and presentability. The editor also checks the names of features given on the lettering diagram accompanying the drawing, confirming their spelling from various authentic sources, such as atlases, postal guides, decisions of the United States Board of Geographic Names, etc.

While the editors are checking the lettering, topographic draftsmen ink on one metal mounted blue line print all of the cultural features, on another

[17] The writer has a number of mimeographed copies of this paper and will send one to any member of the Association who expresses an interest.

all of the drainage and on a third, all of the contours. Each of these prints is inked in black ink, because of better photographic quality, although the second is printed in blue and the third in brown in the actual printing processes. The metal mounted sheets prevent distortion of the different drawings and result in perfect register of the different colors in the final printed map.

All names and legends selected by the editors for the final map are printed on transparent tissue paper in specially prepared sheets and accurately pasted in position on one of the metal mounted blue line prints. This lettering sheet is photographed separately from the sheet carrying the cultural features, but can be processed to the same printing plate because both features are to be printed in black.

A separate drawing is not made for the highway classification until a combined proof copy of the culture, drainage, contours and lettering data are available, and non-photographic blue line prints on metal mounted drawing paper are made, so that the highway classification, when printed in red, will not interfere with any of the other printed data.

Boundaries of the woodland areas are sometimes indicated on the pencil drawing, so that they will show faintly when photographed and these are cut by a glass engraver on a specially prepared stained negative during the reproduction process. If these woodland boundaries are not indicated on the drawing, they are shown on a tracing of the pencil drawing, are photographed to the publication scale of the map, and a separate printing plate is made by a lithographic artist by transferring a chalk offset impression of the woodland areas from the photographic negative.

A large modern plant with eight presses is maintained and operated the year round by the Geological Survey, and here the topographic maps are printed on high speed lithographic presses, either direct or offset.

After careful inspection, the finished maps are sent to the stock room, which has storage space for more than eight million maps. From here the Survey distributes more than one million maps each year.

USES OF TOPOGRAPHIC MAPS

The uses to which these million maps are put are as unique and interesting as the story of their creation. Topographic maps are essential to national defense programs, for only from knowledge of the terrain can troop movements be carried out quickly and accurately, assuring perfect maneuvering for defensive or aggressive action. Such maps are the first tools for development and construction of flood control and power projects, for existing physical conditions are the basis on which these projects are built. The maps show the best routes through which modern highways can be

built: in fact in undeveloped country, savings in highway funds are much greater than all mapping costs. Land reclamation, soil conservation, study of water resources, study of drainage problems, inventory of mineral and all other natural resources—all these attempts to make the earth more permanently productive—are based on the information shown on topographic maps. In fact, they are essential to any activity that has to do with the use of the land.

Washington, D. C.,
December, 1939.

The Finns of the Pacific Coast of the United States, and Consideration of the Problem of Scientific Land Settlement

EUGENE VAN CLEEF

In 1915 I undertook a field investigation of Finnish settlements in northeastern Minnesota, in the hope of determining whether or not these settlements are in anyway affected by geographic conditions with which they come into contact. I was not interested especially in the theory of environmentalism, but rather in an opportunity to test out the more or less tenuous theory held at that time, that human migration was effected along isotherms. Of course, all that I could hope to do was to determine the underlying factors affecting the movements of the Finns rather than to establish any sweeping generalizations applicable to all peoples.

This first inquiry was subsequently expanded to include Finns in other parts of the United States, in Canada, in the Baltic Region and in Finland itself. Among various published papers based upon the results of these observations and having a special bearing upon the current presentation, the following are cited:

"The Finn in America," *Geographical Review*, Vol. VI, No. 3, Sept. 1918, pp. 185–214.
"The Finns of Cape Cod," *New England Quarterly*, Vol. VI, No. 3, September 1933, pp. 597–601.
"The Finns in Ohio," *Ohio Archaeological and Historical Quarterly*, Vol. XLIII, No. 4, Oct. 1934, pp. 452–460.

Part I of this discussion which now follows is the fourth paper in a series of observations treating the subject of Finnish settlement in America. This paper is based upon recent field work among Finnish settlements in the Pacific Coast States. In Part II I shall consider the problem of scientific land settlement in the light of Finnish activities in land occupance during the past three-quarters of a century.

PART I. THE FINNS OF THE PACIFIC COAST

The reasons for the settlement of Finns in our western states parallel in many respects those for settlement in the eastern part of the nation. The objectives of the Finns were a better living and an opportunity to rear a

family in a favorable environment. These migrants sought a habitat in which they might capitalize their skills rather than engage in work wholly foreign to themselves. The major environments which attracted them were forests, potential agricultural lands, fishing grounds, navigable waterways and minerals, all similar in their major characteristics to environments in their home country. Even soils, topography, climate and the general aspects of the landscape in the vicinity of most Finnish settlements in America corresponded strikingly with those in Finland.

While there is evidence that a few of the first Finns were enticed by the California Gold Rush of 1849, their numbers were unimportant and their influence upon the migration of other Finns was negligible. Some Finnish sailors arriving at San Francisco as early as the decade 1850–1860 left their ships to join other pioneers, much as Finnish sailors deserted at Boston in 1860. The bulk of the settlers consisted of Finns who came either direct from Finland or from the eastern states with the avowed purpose of becoming permanent residents. Many found employment in the redwood lumber industry of Mendocino and Humboldt counties. Others moved in the direction of Los Angeles and still others migrated northward reaching Marchfield and North Bend, Oregon, about 1865. The completion of the first transcontinental railroad in 1869 was a stimulus to the movement westward of a small number of Finns then living in the Great Lakes Region. About 1870 Finns filtered into Astoria, Oregon, sailors once more leading the vanguard. They were followed in 1873–4 and again in 1877 by groups from Ohio, Pennsylvania and later from the "Copper Country" of Michigan and from western Finland.[1] By 1880 Finns began to settle in the State of Washington, the source of supply being essentially the same as for the other states. After the World War many Finns moved into the Los Angeles-San Pedro district, a region lacking some of the physical characteristics of a "normal" Finnish landscape. Today in Los Angeles County there are nearly 3,000 Finns. Other present-day California Finnish centers are the cities of Berkeley, Oakland, San Francisco, and the counties of Mendocino and Humboldt. The numbers of settlers have grown substantially in all of the coastal states, slightly exceeding 16,000 in California, 12,000 in Oregon and 22,000 in Washington.[2] In the states immediately east of the Pacific Coast group, scattered Finnish communities occur but since their numbers are

[1] Finnish residents of Astoria assert that in 1870 there were 250 to 300 Finns in Clatsop County, whose total population was 1255. The U. S. Census of 1930 credited 4507 Finns to this country.

[2] Some data bearing upon western settlement were supplied in correspondence with Rev. S. Ilmonen, Fort Bragg, California, a Finnish authority on this subject. Assistance was also rendered by E. E. Pajunen, Vice Consul of Finland, Astoria, Oregon, and Karl P. Heideman, Seattle.

relatively few and the reasons for their existence are similar to those for the coastal groups, further consideration of them is unnecessary. The map (Fig. 1) indicates their distribution as well as that of other areas of Finnish occupance in this country.

One of the western settlements of particular interest is that of Reedley, California.[3] Since its location, like that of the group of Finns in Los Angeles County, seems anomalous, for reasons we shall cite, and since the settlement is of fair size, we record its history in some detail.

The Reedley colony grew out of the "Russification" program instituted in Finland during the latter part of the nineteenth century. An exile by the name of Wahren, trained as an agronomist, came to the United States about 1900 from western Finland with the idea of locating land suitable for Finnish settlement, intending to encourage other unhappy Finns in Finland at that time to emigrate to this country. He seemed bent upon a climate more salubrious than that in Finland. His survey of possibilities led him to the San Joaquin Valley, California, where he came upon a colony of Swedes near Kingsburg and Selma. Convinced by the Swedes that this locality was wholly satisfactory for peoples from high latitudes of Europe, Wahren bought land in 1906 about 10 miles upstream from Kingsburg along the Kings River near Reedley. This was a conscious selection of frontage intended to provide waterscapes for future farmers, a setting which would be comparable in some respects to that from which the prospective settlers were expected to come.

At this time, the land was planted primarily in wheat. Grape culture was in its infancy. Wahren advertised the land in Finland as suitable for general agriculture, thus appealing to a number of Finns, glad to escape Russian oppression and to cast their lot with others in a region of seemingly abundant opportunity. He also advertised in Finnish papers published in Northern Michigan, in New York and elsewhere. The immigrants had little money and hence found it necessary, as Wahren did originally, to engage in lumbering in the camps[4] of the nearby Sierra Nevadas until they accumulated enough cash to begin the purchase of small acreages for agricultural purposes. This procedure was typical of that followed by Finnish settlers in New England and the Great Lakes region. The colony now numbers about 400 engaged largely in the raisin industry and in the production

[3] Korsinen, Frank: *Historia,* etc. translated in part by Rev. Raymond Wargelin, Berkeley, California. Also correspondence with both Korsinen, an original settler, and Wargelin, quoting some of the other settlers still occupying land in or near Reedley.

[4] They were employed by a lumber company no longer operating, to work in the redwood forests. (From statement by Frank Korsinen, one of the first Finns to work in these forests.)

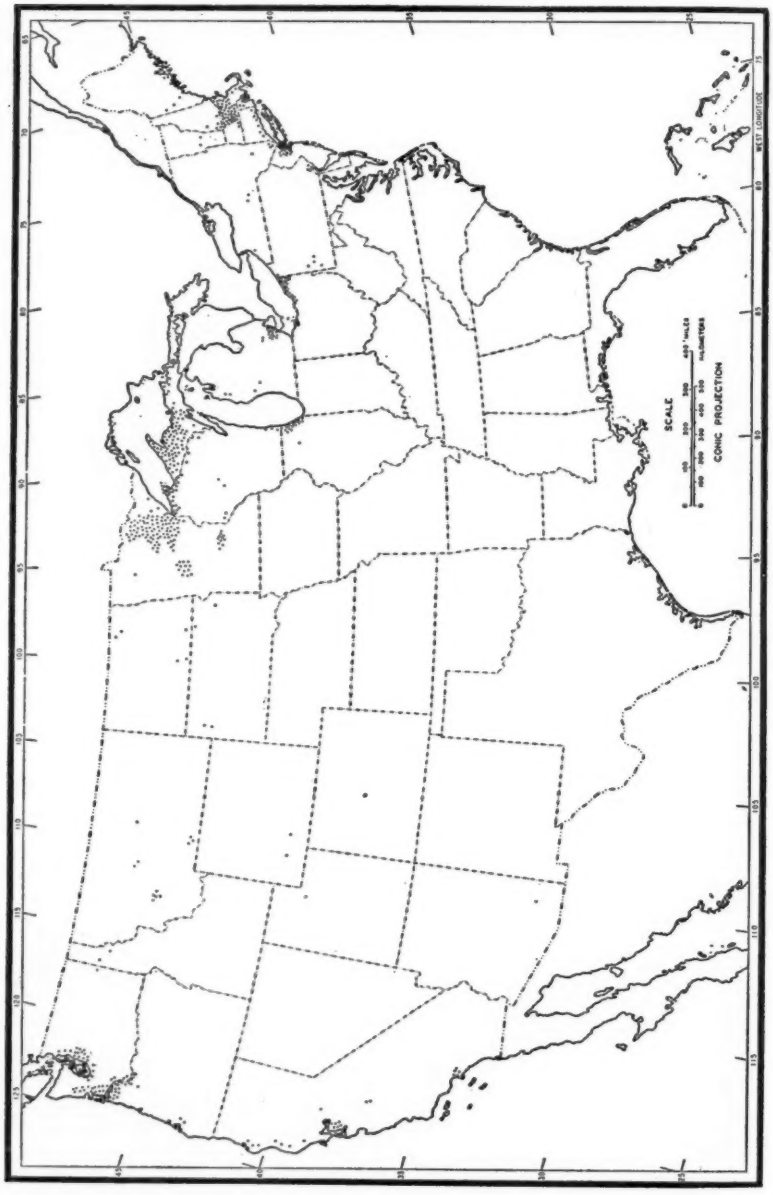
SCALE
CONIC PROJECTION

FIG. 1.—Distribution of Finns in the United States. Each dot represents 500 Finns; the large dot for New York City is proportional to the small dots. (Data from U. S. Census, 1930.)

The number of Finns scattered throughout states in which no data appear is so small as to be negligible.

The striking concentration of Finns in high latitudes was the basis for suspecting a play of geographic elements in their settlement. Only groups located in the southern half of California appear to be a departure from the seemingly "normal" areas of occupance by Finns. For an explanation, see the text.

The maps are drawn on Goode's Base Maps (H. M. Leppard, editor), published by the University of Chicago Press.

of apricots, peaches and oranges. In the entire valley area there may be close to 1000 Finns.

The presence of Finns in Reedley and in the Los Angeles district, we have said, seems to be anomalous. We have pointed out here as in earlier writings (cited at the beginning of this paper) that the Finns generally established themselves in regions physically similar to those in the home country. Probably the greatest disparity between these localities and Finland is associated with the climate. There is no resemblance between the climate at Reedley itself and that of Finland. Nevertheless, within less than fifty miles of Reedley one may enter a climatic region in the Sierra Nevada mountains not unlike that of parts of Finland. It was in this environment that the first Finns spent much time earning their living in lumber camps. Hence, during the early growth of Reedley these people lived in a sort of compromise climatic environment, namely a hot semi-arid climate in the valley and a continental type in the mountains[5] nearby. These same mountains likewise offered forest types and rock exposures similar to those in the home country. In the winter, snow was available for skiing or other sports (Fig. 2). Thus, any longing the settlers might have had for reminders of the homeland were largely satisfied.[6]

In the case of the colonies of Finns in the Los Angeles district, the ocean has been an important factor, affording an outlet for activities associated with the sea and providing sites for summer residences in proximity to a water

[5] A Finn has suggested that adaptation of the settlers to the heat of the Reedley and Los Angeles localities might be attributed to the steam bath, an institution to which all Finns even in the United States, are habitués. As extreme as this view may seem to be, it is consistent with the fact that in steel mills and other factories where certain processes require workers who can withstand excessive temperatures and who have great muscular stamina, Finns, if available, are assigned to such operations. This ability to withstand high temperatures when necessary may, of course, be an inherent anthropological characteristic. Its correct explanation still remains to be established.

[6] "Lack of experience in irrigation methods resulted in failures at first and in considerable hardship. But Finnish persistence asserted itself, resulting in survival and success." Statement by Frank Korsinen.

FIG. 2.—Mean Annual Snowfall and Finnish Settlement. Each dot represents 1000 Finns, except that for New York City, which is proportional. Snowfall is recorded in inches, after *Climatic Maps of North America,* by C. F. Brooks, A. J. Cronin, and others (Harvard University Press, 1936).

The Finn expresses an unqualified desire to live where snow is accessible, although not necessarily excessive. In the southern half of Finland where most of the population of that country lives, the total fall ranges only slightly more than in the Great Lakes Region and Northeastern United States. Hence, the coincidence of settlement and snowfall areas in this country is not surprising.

The striking exception noted in the Pacific Coastal areas is explained in terms of the attraction of certain other physical conditions upon the lowlands with abundant snow easily accessible in the nearby mountains.

body. Then too, the nearby mountain landscapes including winter snows furnish an additional "home" background. These factors have played a critical rôle in supplying elements of interest to the Finns, probably, discounting such aspects as aridity and high temperatures. In spite of these two partial exceptions to the usual reactions of Finns, it is still valid to say that the major environments which hold the interest of the western Finns, as also of the eastern Finns, are the forests, fishing grounds, navigable waters, relatively wet agricultural lands, and minerals.

The appeal of the waterscape, the coniferous forests, boulder strewn and rock-exposed surfaces, and winter snows is not to be interpreted as applying only to those engaged in so-called menial occupations. Lawyers, physicians, journalists, teachers, and many others are attracted by these

natural elements. One might contend that since these persons minister to the wants of the manual laboring Finns, their presence bears no relation to the character of the geographical environment; that it is purely owing to economic reasons. However, a large number of interviews with these Finns, including inquiries among key persons, reveals unequivocal evidence that they would not be wholly contented in other kinds of environments, albeit under extreme economic pressure they might eventually make a satisfactory adjustment.

It seems safe to conclude that the Finns in America reflect a high degree of sensitivity to their physical environment. This response is so positive as to allow of prediction relative to the types of areas in which considerable

FIG. 3.—Major Soil Types in the Regions of Finnish Settlement. Each dot represents 1000 Finns, except that for New York City, which is proportional. Soil types are generalized from the map "Soil Associations of the United States" in *Men and Soils* (U. S. Dept. Agric., 1938).

1.—Podzols.
2.—Gray-brown Podzolic Soils.
3.—Non-calcic Brown Soils.
4.—Alluvial Soils.

In the vicinity of San Francisco and Los Angeles small unruled areas are characterized by Prairie Soils.

The occurrence of Finnish settlements in the Podzol soil areas is consistent with their distribution in Finland. There too the soils are largely Podzols or Podzolic. Finns show a preference for poorly drained lands. In the regions of Gray brownerths they reveal a similar choice. Within the Podzolic areas of the Pacific Coast are small Podzol areas, many of which are concentration localities for Finnish population.

numbers of Finns seeking sites for permanent occupance are likely to settle. Correspondence of settlement with particular physical phenomena is illustrated by maps upon which both settlements and physical conditions are shown (Figs. 2, 3, 4). If these maps be compared with corresponding maps

FIG. 4.—Forest Types and Settlement. Each dot represents 1000 Finns, except that for New York City, which is proportional. Western Forests generalized from *Natural Vegetation* by H. L. Shantz and Raphael Zon (U. S. Dept. Agric., 1924). Eastern forests after E. N. Transeau, prepared for this paper.

Western Forests: Largely Douglas Fir, Yellow Pine, Sugar Pine, and Redwood.

Eastern Forests: Mixed Conifers and Northern Hardwoods: White Pine, Red Pine, Hemlock, White Spruce, Black Spruce, Red Spruce, White Birch, Yellow Birch, Sugar Maple, Beech.

As in Finland so in the United States, Finns occupy regions where the forest type is coniferous-evergreen or birch, or where these two are mixed. Deciduous broad-leaved trees are secondary. The species of trees here and in Finland are not in all cases identical but they are equivalent in type.

of Finland (see Atlas of Finland), striking coincidences may be seen.[7] While coincidence does not always establish cause and effect, in this instance objective investigation throughout the nation and in foreign lands has shown that there is a positive correlation. That correlation is better expressed by

[7] Space does not allow of the presentation of other maps, such as mean annual maximum temperature, mean annual minimum temperature, or a geological map, which reveal similar striking relationships between settlement and physical environment.

the maps themselves than it could be by an elaborate detailed word description of the maps.

In consequence of my first survey in the Lake Superior region (1915–18), the suggestion was made that those who are "encouraging foreigners to settle" the land should encourage the Finn rather than other nationalities because "fundamental facts of his evolution within a well-defined environment" gave "assurance for the agricultural development of northeastern Minnesota."[8] Thus, from the standpoint of the possibilities of settlement of northeastern Minnesota in particular, I attempted to appraise not only the nature of the land and its potentialities, but the characteristics of the people who sought to occupy and develop it. Subsequent studies such as that represented by observations noted above among Pacific Coast Finns as well as those in other areas and comparisons of the American and Finnish natural regions have lent additional support to the contention that in the settlement of new regions, the original habitat of the prospective settler is a matter for serious consideration.

PART II. CONSIDERATION OF THE PROBLEM OF SCIENTIFIC LAND SETTLEMENT

The philosophy here set forth that human characteristics, so far as the Finns are concerned, are closely related to particular physical environments has an important bearing upon the current broader problems associated with settlement and land-use. No claim is made for originating the point of view. I merely present contributory evidence. Bowman recently emphasized the importance of man in the problem of settlement when he said "Geography cannot be useful in the creative experiment unless it measures man as well as his environment. . . ."[9] The conclusions here presented substantiate this assertion.

Since my first search for light upon the relation between Finnish migration and the geographic factor, several elaborate investigations have been made by others into the general problems of settlement in relation to land-use. These have been stimulated largely by a desire to find a way out of the nation-wide if not world-wide economic depression. At this point, an examination of some of the important concepts expressed in these studies is worthwhile.

In his investigations into pioneer settlement, Bowman[10] urges a scientific approach to the problem. However, in his chapter "Science Plays a Part"

[8] Van Cleef, Eugene: "The Finn in America," *op. cit.*, p. 214.

[9] Bowman, Isaiah: "Geography in the Creative Experiment," *Geographical Review*, Vol. XXVIII, No. 1, January, 1938, p. 4.

[10] Bowman, Isaiah: *The Pioneer Fringe*, American Geographical Society, New York, 1931, Special Publication No. 13, 345 pp. & Index.

he directs attention to the practical aspects which may offset conclusions arrived at through science. For example, he cites what irrigation of our western lands has accomplished and remarks that whereas scientifically speaking, irrigation has worked, its effect upon settlement has not been anything to boast about. "The total farming population upon the twenty-four national irrigation projects of the West after twenty years of government aid and generosity was but 140,000" (p. 77). But viewing the problem from the standpoint of opening new lands with the aid of peoples already skilled in irrigation he says, "yet if we were to import Egyptians they would make our government reclamation schemes work because they would accept a standard of living unthinkably low for us" (p. 78).

While the standard of living might be low, so far as many persons in the United States are concerned, we cannot overlook the fact that the concept of "standard of living" is purely relative and that two standards, one of which seems to some of us to be much lower than another, need not mean unhappiness for those who are experiencing the lower standard. Certainly, if we had Egyptians in the United States who had had irrigation experience in their original habitat, the scientific approach to the settlement of our irrigated lands would lead us to encourage *them* to settle on such lands rather than those elements of the population who knew only wet lands. By Bowman's own admission "The technique of farming, if well known to you, is the one you can put into practice without misgiving" (*ibid.*, p. 37). This is an important statement. Certainly, to ask those without such technique to engage in farming would seem to be even more hazardous than to ask farmers to adapt themselves to unfamiliar occupations in urban communities.

From the point of view of certain persons, the Finns who now are farming small acreages of the boulder-strewn wild lands of New England or some of the muskeg of the upper Great Lakes Region or the cut-over lands of Washington and Oregon, subscribe to a low standard of living and hence are leading an unsatisfactory existence. Such a conclusion could be drawn only by those who fail to understand the temperament of the Finn and who have had no intimate association with Finns. A geographer who appreciates the relativity of this idea of standards, investigating a Community of Finns in Minnesota, offers some pointed comments in this connection.[11] He recognizes that in spite of the fact the Finns are having a hard struggle for existence, "it would be a serious mistake to move them to a better area." He does suggest ways that might alleviate the struggle somewhat without unsettling the land. However, he is reluctant to move them elsewhere, because he realizes that in the face of seemingly low standards, they are more nearly

[11] Davis, D. H.: "The Finland Community," *Geographical Review*, Vol. XXV, No. 3, July 1935, pp. 382–394. Also private correspondence with Davis.

contented in their present locality than they would be even on highly productive land.

In another recent population inquiry,[12] an effort was made to determine not only "the relationship between migration and economic opportunity" but the "most effective utilization of our human and material resources." Data were collected relative to migratory movements into previously unoccupied areas and those from farm to city and city to farm. Whereas the authors had hoped at the outset that an immediate solution to their problem might be forthcoming, they quickly became aware that their project involved "the permanence and stability of employment" rather than temporary relief. Hence they posed the question "where will people have the best long run chance of making a good living?"

Though the study was thorough in many respects, the authors apparently overlooked perhaps the most critical factor of all, namely, the capacities of various types of peoples. Their nearest approach to the recognition of this aspect occurs in their review of the approach to the problem of settlement in Germany. There the government controlled migration and in doing so took cognizance of the skills of those about to be transferred from one region to another. Although ethnic or racial factors were virtually of no significance, a distinction was made between persons who had had agricultural training or experience and those who had not. Parenthetically, reference might be made to the method applied in Latvia when that country broke up landed estates after the war and settled them. Officials permitted only those persons to occupy acreage, who could give proof of first-hand familiarity with soil cultivation. As a result, the settlement "mortality rate" at the end of the first five years was less than twenty per cent.

"To determine the possibilities of settlement in any region account must also be taken of the people who are expected to settle in the region. From what lands and climates do they come? Does the stock still display pioneering aptitudes?"[13] This succinct statement by Bowman might well have been deduced from the record of settlement made by the Finns. The story of Finnish settlement gives validity to that statement, at least insofar as this particular nationality is concerned. No assertion is made that it is true for others.

In the same publication edited by Dr. Bowman, one contributor, Dr. Carl O. Sauer, seems to believe that the problem of settlement is no longer an important matter at least so far as world-wide movements are concerned.

[12] *Migration and Economic Opportunity, Report of the Study of Population Redistribution* by Carter Goodrich and others. University of Pennsylvania Press, Philadelphia, 1936, 741 pp. and index.

[13] Bowman, Isaiah, and others: *Limits of Land Settlement—A Report on Present-day Possibilities.* Council on Foreign Relations, N. Y., 1937, p. 3.

He states ". . . it appears to this commentator that the population of the world has become sedentary permanently; that most of its inhabitants are where they belong." He admits that individuals may migrate but their "offspring will not be colonists. They will pass into the communities that receive them" (p. 23). One cannot be certain whether Sauer believes that all peoples in the United States are now where they belong. While we may not ordinarily expect migratory movements such as those of the past 2000 years to be continued during the next similar period, yet to conclude that migrations are about over is perhaps a bit premature. More probable it is that we are entering upon an era in which migration will occur under scientific guidance and in general with greater intelligence than in times past. Hence, it is of the utmost importance to analyze minutely man's past and present experiences in order that future readjustments and realignments of population may be accomplished in the interests of the maximum welfare of both the individuals concerned and the nation.

That the importance of considering the adaptability of peoples to a given milieu has been recognized by a few organizations having a share in planned settlement is revealed in a statement by W. A. Mackintosh in his chapter on "Canada as an Area for Settlement" in the book on *Limits of Land Settlement* just cited. Mackintosh in discussing immigration into Canada prior to 1930 says:[14] "Greater encouragement was given to immigrants from northern than from southern Europe." This program was in the hands largely of two railroad companies, organizations that learned by the method of trial and error, but nevertheless learned well.

Evidence is also available to show that adaptability involves not only experience with the materials of a given environment but a "way of life," and this is something more than mere "standard of living" as that expression is commonly interpreted. The concept is reflected in statements made by Hartman and Black based upon their studies of the economic aspects of settlement in the cut-over lands of the Great Lakes region.[15] These men discuss farm reversion, that is, abandonment in various unit areas of the region and reach certain pertinent conclusions with reference to the Finns and to foreign land-owners in general. They say: "Regardless of this situation (that is, low wet cut-over lands) there is little farm abandonment, (in Settlement Area 17)[16] and a strong cooperative community spirit prevails.

[14] *Op. cit.*, p. 81.

[15] Hartman, W. A., and Black, J. D.: "Economic Aspects of Land Settlement in the Cut-over Region of the Great Lakes States." *Circular 160, U.S.D.A.*, April, 1931, pp. 77–78.

[16] References to Settlement Areas in these quotations are to units which the investigators set up for their own convenience in making their survey. Their detailed location has no significance in this paper.

All but three of the settlers surveyed were Finns who had had farm experience before settling here. These Finlanders have proved to be hard workers and willing cooperators. As a consequence, abandoned farms are likely to be few in number."

Again with reference to Settlement Areas 18 to 33 they say: "Finlanders predominated in 8 of the remaining 13 areas showing less than 10 per cent of farm reversion between 1920 and 1928; Danes predominated in 4 areas, and natives of Austria-Hungary constituted the majority of settlers in the remaining 2 areas. Although it would be necessary to analyze many contributing factors in order to account for the lack of or small amount of farm reversion in settlement areas 18 to 33, observations suggest that nativity of settlers is of primary importance. The land in three areas (19, 29, and 33) is of poor quality for farming purposes, and in areas 23 and 32 it varies from good to poor; yet farm abandonment by the foreign-born settlers is decidedly lacking. One of the reasons for this is that, in general, foreign-born settlers are willing to work longer and harder and maintain a lower standard of living than is the average native-born settler. They are willing to sacrifice more than the average to satisfy a desire for land ownership."

Hartman and Black refer to the willingness of these foreigners (including the Finns of course) to "maintain a lower standard of living than is the average native-born settler." However, this assertion is really off-set by the sentence which follows, if we interpret land ownership as evidence of high standards. The Finns will accept a "lower standard in order to satisfy a desire for land ownership." Actually, this does not mean that they accept a lower standard permanently. In the first place, they are pioneering on the lands in question, a stage of economic activity which demands sacrifices. Secondly, they must accept "a lower standard of living" which this stage involves in order ultimately to achieve their goal, namely, land ownership which usually is accepted as an index of high standards.

Oftentimes experts classify lands as submarginal having in mind certain standards of living which would satisfy their own needs. They overlook the fact that what is submarginal for some may become marginal in the hands of others; that what may be "unprofitable" for some settlers may be profitable for others. Satisfactions, contentment and other elements that seem to make life worthwhile are relative and to the Finns, accustomed to given types of natural environments, these satisfying factors may be forthcoming when to other peoples they may not. That this is the case is readily demonstrable by the Finns' own testimony and observations among them as pointed out in the papers cited at the beginning of this presentation, and in secondary papers not listed here. In any scientific analysis of land occupance, we should not overlook this point of view. There are persons

who argue that the national well-being is paramount to that of a particular individual or group and, therefore, human energy should be spent upon lands which will yield the largest returns for the effort put forth. However important such a policy may be, it does not relieve us from our duty when classifying lands with a view toward their potentialities for settlement, to give analytical consideration not alone to the lands, but to the human half of the equation. We cannot afford to lose sight of the well founded statement that a nation consists not alone of land but of land plus people with the intelligence to use it.

I have cited evidence not only in this paper but elsewhere to show that so far as concerns Finns, the physical environment must incorporate something other than mere potentialities for successful farming if these people are to be attracted to land for permanent settlement. Finns have refused time and again to settle in areas where survival was relatively easy. They have refused because the climate was not to their liking, or because the landscape lacked a coniferous vegetation, or because there was no waterscape close at hand or the soil types were unfamiliar to them. It is possible that this highly sensitive response of the Finns to their geographic environment is unique; that other people do not react in this manner. This remains to be demonstrated. The record of the Finns observed over a score of years would seem to warrant similar studies among other ethnic elements.

Where nations possess a more or less homogeneous population, settlement adjustments are relatively simple. Perhaps under such circumstances the significant factor to be interpreted is the effect which length of residence in given environments may have had upon the respective inhabitants; but in a nation like the United States where there are not only diverse habitats in striking contrast to each other, but diverse ethnic groups and individuals, the problem is greatly complicated. Scientific settlement demands investigations of the reactions of peoples to their *original* habitats as well as their reactions to their adopted environments. In his book on the Pioneer Fringe, Bowman recognizes that even "modern pioneers differ from country to country and each type has its own standards of comfort and success" (p. 9). And again "Some races are tolerable to social isolation; others are not" (p. 10). These are points that may not be ignored "if there is to be a greater degree of social control over the distribution of population" as Goodrich and others advocate,[17] a control whose "main purpose should be not to reduce human mobility but to make use of it and to give it surer direction and guidance" (p. 9).

The Ohio State University,
May, 1939.

[17] Goodrich, Carter, Allin, B. W., and Hayes, Marion: *Migration and Planes of Living, 1920–1934.* University of Pennsylvania Press, Philadelphia, 1935, 111 pp.

Henry Chandler Cowles, Physiographic Plant Ecologist

CHARLES C. ADAMS AND GEORGE D. FULLER*

The development of genetic physical geography in this country, at the hands of Powell, Gilbert, Davis and Salisbury, emphasized the great fundamental importance of the study of geographic processes. That dynamic line of approach to problems concerning physical features was soon carried over into the study of the biological aspects of geography and into the field of human problems.

Henry Chandler Cowles, physiographic plant ecologist, whose recent death is occasion for this note, was one of the first American students of the dynamic aspect of vegetation and plant distribution. In his college years he was greatly interested in taxonomic botany and the local distribution of plants as well as in geology. As a fellow and graduate student at the University of Chicago he devoted himself first to Pleistocene paleobotany and came under the inspiring influence of the late Professors Rollin D. Salisbury and T. C. Chamberlin. When the late John M. Coulter became professor of botany at Chicago, Cowles took up studies with him. Encouraged by Coulter to enter the newly opening field of ecology, and greatly inspired by a wealth of new ideas gained from Warming's celebrated first text-book in that field, Cowles rapidly developed new dynamic concepts of plant distribution and vegetational change through prolonged and indefatigable field study in the dune region at the southern end of Lake Michigan. He was peculiarly and fortunately well fitted for that fine pioneer work because of his rare combination of creative interest in systematic botany, glacial geology and physiography. An accomplished student of physical geography, he had ample first-hand acquaintance with the plants of this region; equally accomplished in botanical science, he was already thoroughly familiar with the physiographic concepts of erosion cycles and glacial topography. It was mainly in this realm of dynamic or genetic physiographic plant ecology that he was to become eminent.

His dissertation for the doctor's degree at the University of Chicago, "The Ecological Relations of the Vegetation of the Sand Dunes of Lake

* The authors wish to express their appreciation to Dr. Burton E. Livingston for his very valuable assistance in the preparation of this sketch.

Michigan" (published in the *Botanical Gazette,* 1899), was a startling revelation of a new kind of approach in biology. It was soon followed by his equally well-known paper on "The Physiographic Ecology of Chicago and Vicinity" (published in the *Botanical Gazette,* 1901), in which the principles of plant succession and vegetational climax that he had developed in connection with his dune study were extended to apply generally to natural vegetation in the Chicago region. In his presidential address before the Association of American Geographers, in 1910, on "The Causes of Vegetational Cycles" (these *Annals,* Vol. 1, pp. 1–20, 1911), he presented a summary of his thought concerning ecological succession. Regarding this address Dr. W. M. Davis remarked (these *Annals,* Vol. 14, p. 205, 1924) when discussing the migration of organisms in relation to the cycles of erosion that: "Its first statement by Woodworth in 1894 (J. B. Woodworth: "The Relation of Baseleveling and Organic Evolution," *Amer. Geol.,* 14, pp. 209–235, 1894) showed in a highly original manner the possibility of extending the scheme of the cycle of erosion into the biological field.[1] Its value with respect to plant formations, along with a historical review of the gradual introduction of the idea involved, was ably presented by Cowles in his address as president of the Association of American Geographers, in 1911, an address of such importance that it alone justified the forming of that organization; for the speaker then made it clear that the description of the flora of a region from this point of view is not only practicable but illuminating. There can be little question that the line of geographical progress thus indicated will be followed in the future." This forecast by Davis has been amply confirmed. Irrespective of the ultimate value of the cycle of erosion and of the baseleveling hypotheses, it has opened up a valuable field in its application to faunal and floral problems as well as in the general field of ecology.

With Professor Coulter, he began teaching plant ecology to an enthusiastic group of students in 1897, and this field was soon turned over to him for cultivation. From the start he was a remarkably successful teacher and he promptly became a recognized leader. The regional and geographic aspects of ecology were always happily emphasized in his lectures and conversations and he kept the research spirit brightly alive in his classes. His students have gone on to extend the Cowles methods and concepts in many ways, developing in this country one of the world's most active centers of ecological study. It is of special interest to note that Coulter's remarkable early appreciation of the prospects and promise of the new science of plant

[1] This was also proposed independently in "Baseleveling and Its Faunal Significance, with Illustrations from South-eastern United States." (*Amer. Nat.,* Vol. 35, pp. 839–852, 1901.)

HENRY CHANDLER COWLES, 1869–1939

ecology promptly bore fruit in the work of Cowles and his students and also soon spread to the neighboring zoological department, where Professor C. M. Child's physiological point of view may be regarded as a direct outgrowth of the general ecological atmosphere of the university. Many years later that atmosphere exerted a favorable influence in the extension of plant and animal ecology to the still newer field of human ecology. The Chicago ecologists have been characteristically geographically minded.

Those who knew Cowles best will regret that he did not publish in greater detail the results of his extensive field and literary studies. He devoted himself mainly to his students, rejoicing in their progress and in their subsequent accomplishments. They received the benefit of many of his observations and ideas that might well have been printed for a larger group of readers. For example, he carried out an able study in paleoecology to help Chamberlin and Salisbury when they were engaged in writing their epoch-making "Geology," presenting his results in class-room lectures before any similar work had appeared anywhere. Characteristically fair-minded, modest and never at all aggressive, the full value of his scientific work has not always been adequately recognized. But an excellent general account of his attitude and manner of thought is to be found in the ecology volume of the well-known "Chicago Textbook of Botany." The first edition of that text appeared in 1911 and Cowles's part was revised and greatly enlarged in the later edition of 1931 by George D. Fuller. With his clear and critical habits of thought, with his early appreciation of the physiological point of view in biology, he was able to develop his subject with remarkable freedom from those teleological implications which were so common in the biological philosophy of his earlier years. He was among the first writers in his field to emphasize continually and consistently the principle of multi-conditional control in natural processes. He always regarded the present as the direct outcome of what has happened in the past rather than as purposeful striving toward the future. Always supremely enthusiastic in his interests, Cowles was never dogmatic. He preferred to use non-technical language, avoiding new terminology and the formulation of any rigid system for his science.

No teacher was more successful than Cowles in bringing students directly to nature as well as to books. He believed thoroughly in out-of-doors teaching, making nearby vacant lands his ecological laboratory. He was an inspiring and enthusiastic leader on many field trips to more distant regions; some of the trips occupied only a single day while others were longer, and some lasted many weeks. He had the instincts of a scientific explorer, he was always a lover of wild nature, from which he derived both facts and generalizations. He was thus led to take an active part in several

lines of nature conservation. No one was more influential in the establishment of the Forest Preserve of Cook County and the broader system of state parks in Illinois.

Cowles was active in many science organizations. For many years he was president of the Chicago Academy of Sciences. He was a charter member of the Illinois State Academy of Science, in which he retained an active interest. He was a patron of the Geographic Society of Chicago and was one of its trustees for many years. He was one of the little group who met at St. Louis in 1903 to consider the organization of professional geographers which afterwards became the Association of American Geographers. He was president of that Association in 1910, vice-president and chairman for the botanical section of the American Association for the Advancement of Science in 1913, president of the Botanical Society of America in 1922. It was largely through his efforts and those of his former students that the Ecological Society of America came into being in 1914. He was its first secretary-treasurer and was its president for 1917. His world-wide leadership in plant ecology brought to him the presidency of the section of phytogeography and ecology at the International Botanical Congress held in Cambridge, England, in 1930.

Born at Kensington, Connecticut, on February 27, 1869, Cowles received his early formal education in the public schools and in the New Britain High School. He was graduated with the degree A. B. at Oberlin College in 1893. He spent the year 1894–95 teaching natural science at Gates College in Nebraska, and for the following year he was appointed to a fellowship in the newly founded University of Chicago, where he became assistant to Professor Coulter in the department of botany in 1897, receiving the Ph.D. degree in 1898. From then onward he was advanced repeatedly in rank until 1911, when he attained full professorship. He was chairman of the botany department from 1925 until his retirement in 1934. After many years of efficient service on its staff, he became editor of the *Botanical Gazette* in 1926, and he relinquished that important and influential post in 1934. His alma mater, Oberlin College, honored him with the degree Sc.D. in 1923.

From the special issue of *Ecology* for July, 1935, which was dedicated to Cowles by his students, friends and colleagues, are taken the following paragraphs, from the hand of Professor W. S. Cooper, of the University of Minnesota:

"A man may be a great scientist and a great teacher and yet inspire in his colleagues and students little affection or none at all. With Cowles it was far otherwise. Something more than mere respect for high scientific attainment is necessary to account for the fact that, when the plan of this special number of *Ecology* was made public, more than three hundred per-

sons responded. With almost every contribution came a letter expressing admiration for Cowles as a scientist, as a teacher, and above all, as a man. These facts speak for themselves; formal tribute is superfluous. And yet, merely because it is a joy to do so, we make mention of a few of his many lovable traits—his unfailing good humor, his far-famed ability in telling a story, his readiness to give ungrudingly of time and effort in the service of students and friends, his eagerness to discover and commend whatever was meritorious in the work of a fellow scientist or admirable in the man himself.

"He relinquished his active labors secure in the consciousness of work well done, confident of achievement beyond the ordinary lot. He laid the foundation for a new and useful branch of science, he constructively influenced the thought of hundreds of investigators and teachers, and in his professional and personal contacts he made for himself a multitude of devoted friends."

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December, 1939.

Titles and Abstracts of Papers
Chicago, Illinois, 1939

CLAUDE H. BIRDSEYE.

Stereoscopic Phototopographic Mapping.

Presidential Address. Published in full in this issue.

CHARLES C. ADAMS and GEORGE D. FULLER.

A Memoir of Henry Chandler Cowles, Physiographic Plant Ecologist.

Published in full in this issue.

WALLACE W. ATWOOD.

The Fundamental Bases for the Study of Geography.

No one will ever go very far in the study of geography who does not understand the fundamentals of mathematical geography, the origin of the present land forms, the changes in climate, the nature and distribution of the natural resources in the ground, the differences in soils, in the major plant societies, and the nature and tendencies of the human beings who are at work in the various habitats on this planet.

We are engaged in a study of the surface of the earth and of the life thereon at the present time. We have passed beyond the stage when we are satisfied with just a description of the earth and its people; we are endeavoring to develop a science which in the end should contribute to a better understanding of the living conditions and problems facing the various communities of people inhabiting this earth. Our opportunity to make such a contribution rests in large part upon our superior knowledge of the stage setting, other specialists in human affairs neglect that field of study, and upon our unique opportunity, and I trust ability, to see the problem of a region as a whole. If we develop such a science it will have the power of predictability.

We may think of the goal towards which we are moving as an understanding of the great human dramas which are in progress in the various geographic regions. Those dramas are continuous, and all who are present are actors.

The superstructure in our science is human geography, but unless the superstructure rests upon a well constructed foundation it will crumble, and any who venture to build such a superstructure without a thorough knowl-

edge of the fundamental phases of the science are doomed to disappointment. We should have in our professional group specialists in each phase of geography. We should welcome research work carrying forward the frontiers of knowledge in any one of those phases. They are essential parts of geography.

WALLACE W. ATWOOD and WALLACE W. ATWOOD, JR. (presented by the junior author).

A New Interpretation of the Physiographic History of the Front Ranges of Colorado and Southern Wyoming.

In this interpretation of the physiographic history of the Front Ranges of Colorado and southern Wyoming an early Tertiary period of erosion of real significance is recognized. The land surfaces developed at that time have been so long exposed and so much elevated that they are today either destroyed entirely or so much modified that it is exceedingly dangerous to accept any one of them as part of a peneplain. In other portions of the Rocky Mountains an Eocene erosion surface was buried and has remained buried to the present day. In the Front Range, where it has been exposed, its topography at the time of its formation has been destroyed.

Then came another period of mountain growth, followed by a very long and important period of erosion and filling. That was the time when the mid-Tertiary formations accumulated and the Rocky Mountain Peneplain was developed.

Another period of uplift and the streams began their work of removing the mid-Tertiary deposits and of dissecting the ranges. It was during this time that most of the streams found themselves superimposed on buried portions of mountain ranges, and as they proceeded with their work they cut great water gaps in the Rocky Mountain region.

As stream erosion continued, the Pleistocene period opened and at least three distinct stages of glaciation followed. Renewal of mountain growth caused still greater deepening of valleys and of canyons, and several incompleted cycles of erosion are thus recorded.

CLARENCE E. BATSCHELET.

Rural Enumeration Control as a Census Aid to Geographic Research.

A system of rural enumeration control will be put in operation for the Census of 1940. Each enumerator will key all rural dwellings within his district by number to the population, agricultural, and housing schedules obtained in the field. Provision will be made for indicating not only individual dwellings but composite dwellings, dwellings grouped in unincorporated places, vacant dwellings, farms being operated on which no persons

reside, non-residential structures, the location of all missing roads, and the location of churches and schools. Census supervisors in rural areas will then be able to tell at a glance what portions of the enumerator's map have not been canvassed as well as make such spot checks as may be required to assure accuracy.

Besides this valuable control feature improving the general accuracy of the census, this system, for the first time, will provide the means for a special tabulation to be made at cost of any and all of the complete subject matter covered by the censuses of agriculture, population, and housing, for virtually any rural area in the United States, no matter how unusual the boundaries of the area may be. This system, therefore, makes possible a significant departure in the use of rigid statistical or political areas and offers a high degree of flexibility in the application of census statistics to the manifold interests of research in the broad field of geography and to many other problems of human concern.

CLAUDE H. BIRDSEYE.

Decisions of the International Geographical Union.

There are two decisions of the International Geographical Union which have been made since I reported to you at Cambridge on December 27, 1938. These are as follows:

The unit of annual subscription by the countries which adhere to the International Geographical Union was fixed to maintain the value in fine gold that it had on August 31, 1934, the date on which the General Assembly at Warsaw established it at 400 French francs, which was 23,580 grams of fine gold. The value of this amount of fine gold shall be calculated at the beginning of each year in the exchange of each country registered in the Union, according to the quotation on January 15 at the London Exchange for an ounce of fine gold (or the latest quotation preceding that date) and shall be transmitted by the Secretary of the Union to each country registered in the Union.

At the suggestion of the U. S. Department of State, I wrote the Secretary General that the United States cannot pay dues to any International Union on the basis of a certain number of grams or ounces of fine gold, or the value of such quantities in dollars, as may be fixed on any exchange on any date, but must pay dues on the basis of some fixed unit. I also wrote the Secretary General that the United States preferred to pay its dues in the equivalent of gold francs. At the market value of fine gold on the London Exchange on January 16, 1939, the eight (8) units of contribution by the United States would be 646.027 gold francs or $211.06.

On May 2, 1939, the Secretary General wrote to the National Research

Council that the International Geographical Union accepts this method of payment, with the understanding that it is a recurring amount, subject only to changes in rates of exchange. The National Research Council replied that the matter had been presented to the Department of State and would probably be approved by Congress. However, the Secretary General was informed that it was doubtful that payments at the new rate could begin until the fiscal year 1941. The 1940 appropriation for dues to the International Geographical Union was $125.44.

The second decision pertains to the choice of meeting place for the next International Geographical Congress. On June 17, 1939, President de Martonne wrote me that the Executive Committee had decided, by a vote of five to two, to hold the 1942 Congress at Lisbon. I have not been informed of the exact date of this Congress.

W. O. BLANCHARD.

Seventy Years of the Suez Canal.

For 70 years the Suez Canal has played a leading role in the world's commerce as well as in European politics. Its strategic location both for peace-time traffic and for military and naval operation has made its construction, operation and control matters of great international concern. The major problems of those in charge have been diplomatic in character rather than engineering.

The bulk of Suez shipping moves between western Europe and the borders of the Indian and Pacific oceans, *i.e.,* between a highly industrial region and an area which is chiefly a producer of food-stuffs and raw materials. As a consequence, there is bound to be a considerable lack of balance in the tonnage moving in opposite directions.

A more detailed analysis of the traffic shows that of the regions east of the Suez in a recent year the Far East and India together account for about one-half of the tonnage movement, the rest being widely scattered. Of the commodities moved from north to south, the metals and machinery group lead, followed by fertilizers, cement, railway material, and coal. From south to north the leading classes are mineral oils, vegetable oils, cereals, textiles (burlap), and minerals (manganese, tin). The cargo tonnage moving north is about twice that southbound.

Suez must of course compete with other routes, especially with that around Good Hope. In addition there are Panama and Magellan, not to mention overland routes from Europe via rail, air and pipe lines. The severity of the competition these offer varies, of course, with the particular regions concerned, as well as with a large number of factors which change from time to time, *e.g.,* charter rates, canal tolls, insurance rates, fuel prices enroute, etc.

The importance of the Suez Canal to England's Empire explains that country's interest in Palestine, Trans-Jordan and Egypt. Yet strategically, the Canal is probably of less importance during war time for merchant vessels than formerly. Modern air craft and submarines have made the Mediterranean so hazardous that steamers are then usually diverted via Good Hope. During the World War about one-half of the British losses of merchantmen were in the Mediterranean and this when both France and Italy were allies and all the others were neutral except Bulgaria and Turkey.

Suez tolls are kept high—"as high as the traffic will bear." The traffic for the Panama Canal, whose capital investment and maintenance are much higher, is from 20% to 33% lower than for the Suez. As a consequence, the stockholders have grown rich while complaints from shippers have been loud and long. Dividends for the past three years have been 50%, and for the past half century they have never been less than 25%.

DAVID I. BLUMENSTOCK. (Introduced by C. W. Thornthwaite.)

Spring Drought Expectancies in the Great Plains and Adjacent States.

A high percentage of the crop failures occurring in the Great Plains and adjacent States is directly attributable to drought. A quantitative measure of drought hazard is therefore desirable in order that needed adjustments in land utilization may be made.

By defining drought as constituting a period during which no two consecutive days receive as much as .10 inch of precipitation, it is possible to tabulate the length of drought periods by month, season, and year; and from these tabulations to calculate the corresponding drought expectancies. Proceeding in this manner expectancy maps have been prepared by season and year for the entire United States using four definitions of drought in addition to the one referred to above. To supplement the maps drought expectancy curves by month, season, and year have been constructed for 225 selected stations throughout the country.

In the paper presented before the Association, one-, five-, and ten-year Spring drought expectancy maps of the Great Plains and adjacent States were presented and discussed as to statistical reliability, meteorological interpretation, and agronomic significance. Likewise seasonal and annual expectancy curves for Pierre, South Dakota, were displayed. These examples were supplemented by four seasonal maps of one-, five-, and ten-year drought expectancies for the entire United States, which appeared in the exhibit. A map on which were shown composite seasonal expectancy curves for selected stations throughout the country was likewise placed on display.

This study illustrates that through the analysis of the frequency of occurrence of critical climatic values, climatic risk may be expressed in expectancy terms which can be concretely applied to agronomic, land use, and conservation problems.

RALPH H. BROWN.

Forest Openings of the Chickahominy Peninsula.

Interest in the low country of Virginia, as represented by the Chickahominy peninsula, attaches mainly to the openings which interrupt an otherwise ubiquitous forest. The distribution of the openings is disclosed by a perspective regional diagram which encompasses that part of the neck of land between the Chickahominy and the James known politically as Charles City County. Evident from this diagram is the constancy with which the same features are everywhere repeated, thus recommending a more restricted study through the transectional method. To include all the known variants, a transection ten miles in width was found essential; this strikes north-south across the peninsula from the cross-roads hamlet of Providence Forge to a group of estates on the James River north shore.

The details of this transection, represented by map and diagram, form the factual basis of an ensuing analysis designed to identify openings of three main classes—the inherited, the adventitious, and the decadent. Unquestioned examples of the inherited group are associated with the quasi-plantations along the James River. In these land holdings, which are periodically subject to changes of tenure and function, the openings have retained a remarkable degree of permanency. Adventitious openings are best represented in the central peninsula where a seemingly planless array of openings large and small encloses the villages and farms of Negroes now, quantitatively, the dominant racial group. Transitory or decadent openings are represented by the area formerly included in a now decadent Chickahominy plantation, Mt. Stirling, itself formerly a segment of the inclusive Providence Forge estate. Records of various kinds, including relict features now directly observable, fortified with the testimony of residents, are sufficient to reveal the residual nature of the openings in this part of the transection and also the extent of reversion to woodland within recent times.

KIRK BRYAN.

The Retreat of Slopes.

The challenge of the Davis' doctrines of geomorphology by W. Penck would be of relatively small importance except that it reveals our lack of emphasis on the study of the retreat of slopes. Do the slopes of humid regions continually flatten during the progress of the cycle? The slopes of

arid and tropical regions appear to maintain their steepness until all the area above the pediment or foot slope is consumed. Recent work indicates that there are many processes and subprocesses involved in the retreat of slopes in humid lands. There is no indication that these processes are affected in their intensity by mere passage of time, and it appears that the slopes of residuals above a peneplain in a humid region should retain the same inclination of slope that they had earlier in the cycle.

MEREDITH F. BURRILL. (Introduced by Clarence F. Jones.)

The Printing Industry: A Study in Zonal Agglomeration.

The printing industry is one of those which by their repeated occurrence characterize certain urban zones. The great metropolitan centers with their sharply defined zones have most of the industry's plants, emphasizing the importance of accessibility, the key to the industry's location in agglomerations within the zone just outside the commercial-financial core. The small plants in this custom industry require nearness to the businesses in the core and cannot themselves afford core locations, even if suitable space were available. Agglomeration results from multiplicity of plants, identical site requirements and limited optimum sites, specialization within the industry and inertia. Industries take character from their locational zone while giving character to it. Recurrent association in a characteristic zone is one criterion of industrial type, a step toward a classification of manufacturing industry.

WILLIAM T. CHAMBERS.

Shopping Areas of Texas.

It is primarily a series of maps that I have prepared for your consideration today. The first three maps present the development of an idea, and it is chiefly with them that my remarks deal. The first is an enlarged copy of a map published by the San Antonio Express. It bears the caption "Texas Trading Areas, as presented in Sales Management Survey of Buying Power, Published in *Sales Management,* April 10, 1938." Using data from this copy of *Sales Management,* I prepared the second map of the series and named it "Trading Areas of Newspapers Published in Leading Texas Cities."

Differences between these two maps, both of which were based upon the same data, led me to investigate the question of Texas Trading Areas further. About 150 questionnaires were sent to the Chambers of Commerce in as many cities and towns which careful map studies suggested might have doubtful commercial affinity. From replies from all the larger towns and most of the smaller ones addressed, the map named "Shopping Areas of Texas" was prepared. Highway maps proved useful in this

work, as well as such knowledge of shopping centers and shopping people as I command. Where data were conflicting, I accepted that which seemed more reasonable and impartial.

Perhaps the most significant fact revealed by this survey is the dominant position of Dallas in the shopping business of Texas. Not only does that north Texas metropolis command a large and rich shopping area of her own, but her great stores attract much discriminating trade from sections dominated by other leading centers. This situation is in conformity with Texas geographic conditions. Houston, San Antonio, and Fort Worth are other great shopping centers of Texas, while both El Paso and Amarillo command large tributary areas.

The most complex shopping area of Texas is in the Lower Rio Grande Valley section. No one city dominates the shopping trade of that district. Rather some three or four centers share the trade of the area more or less equally, a situation quite different from that in other parts of Texas.

There is a tendency for smaller shopping areas to be tributary to the nearest outstanding center, but each area recognized upon this map has considerable commercial independence.

The trade territories of some Texas cities extend beyond the state boundaries, and three small sections of Texas are tributary to out-of-state centers.

RAYMOND E. CRIST. (Introduced by W. O. Blanchard.)

Some Phases of the Peasant Problem in Yugoslavia.

It was only after the World War that an attempt was made to break up the feudal pattern in Yugoslavia. The great landed estates were broken up and land grants were made to the peasants. But the peasant had no credit; besides, the plots were often too small. Thus in many cases the peasants were even worse off than before, and there was actually less land under cultivation than before the war. A rapid survey of peasant life in Croatia shows that the peasants have a very low standard of living. Most of them are in debt; taxes are very high. Certain changes are suggested which might result in an improvement of the lot of the peasants. The birth rate should be more closely related to the possibility of making a living. There must be economical integration. The rural areas must have access to industrial regions—either foreign or domestic—which will complement them. Security of tenure in his land must be granted the peasant.

HELLMUT DE TERRA. (Introduced by D. W. Johnson.)

Some Critical Remarks Regarding Walther Penck's Theory of Piedmont Benchlands in Mobile Mountain Belts.

W. Penck stated that mobile mountain belts are characterized by pied-

mont benchlands of which it was said that they originated from undulating ge-anticlines, ("Grossfalten"). A critical examination of the structural and stratigraphic premises of his views leads the author to the conclusion that there is no factual geologic basis for Penck's view regarding the uninterrupted continuity of uplift of young mountain ranges during the Cenozoic Epoch. Stratigraphy and structure point to intermittent uplifts which are held sufficient in explaining successive stream-nick production of pre-glacial landsurfaces. The lawful arrangement of relief zones in young mountain ranges, such as W. Penck described from various lands, actually exists, but in the author's opinion such arrangement is due to upheavals interrupted by long intervals of crustal quiescence permitting of maturing processes in stream erosion. Hence W. Penck was right in saying that in mobile mountain belts remnants of piedmont benchlands are not so much the results of strike faulting as of uparching and in no known instance connected with a successive downfaulting of a Paleozoic peneplane.

C. Lorenzo Dow. (Introduced by Nels A. Bengtson.)

Some Phases of Land Utilization on the Goshen Hole Terraces of Nebraska.

The Goshen Hole basin contains about 4,000 square miles divided almost equally eastward and westward by the Wyoming-Nebraska boundary line and northward and southward by the North Platte River. Several large buttes and mesas are conspicuous south of the river, but the northern portion consists almost entirely of an extended fourfold terrace system. The terraces, cut in Tertiary Brule Clay bedrock, are predominantly covered by channel gravels of Rocky Mountain origin capped on the average by three feet of windblown detritus sufficiently fine in places to be designated as loess.

Darton[1] suggested that the basin was once a wider river channel containing the buttes and mesas as islands. However, the nature of the surface detritus and the fourfold terrace arrangement suggest that the basin was cut during cycles of greater river activity coincident with the major periods of glaciation. Accordingly possible terrace-level designations are: Wisconsin, Iowan-Illinoian, Kansan, and Nebraskan; and the buttes and mesas may be remnants of inter-fluves associated with the south side tributaries.

Among other factors, the extent and levelness of the terraces made this one of the first High Plains areas to experience large-scale irrigation. On the large flats and fine textured soils of the first and second levels the early enterprises were especially successful. This may have been the reason for the selection by the Reclamation Service of the higher more broken terrace

[1] U. S. G. S. Prof. Paper 17, p. 22.

levels as the locale for its maiden venture into large-scale irrigation. At first this adjustment seemed sound. Later developments showed the irrigation of a large percentage of this land to be questionable. Seepage and alkalinization increased greatly in the better soils of the lower private districts. Water losses increased through the complex jointing common to the Brule Clay bedrock. "Tightness" of the fine textured soils, and Brule clay prevented successful drainage of seeped areas. The up-river impounding dams destroyed the flood competence of the river thus preventing adequate removal of the drag load brought in by the below-dam tributaries. The resultant rise of the channel bottom with corresponding lift in the water table helped to water-log the flood plain and lowest terrace. On the higher terraces thousands of acres to which a kindly government had brought water at great expense have been abandoned because of course soil texture and rough surfaces. All told over 50,000 acres once irrigated have reverted. Many of these maladjustments could have been prevented by better coordinated use of the information then available and better planning. Such work could have been done by trained geographers. We wonder what if any careful detailed surveys along these lines are being made in the similar gigantic projects now under construction in other sections of the country.

LOYAL DURAND, JR.

The Dairy Region of Southeastern Wisconsin and Northeastern Illinois.

Rural landscapes in extreme southeastern Wisconsin and northeastern Illinois depict many cultural forms which bespeak an outstanding dairy industry. In juxtaposition to these regions are the large and nearly continuous urban areas of the Lake Michigan shore, individual cities of which are located from Manitowoc and Sheboygan, Wisconsin, southward through the urbanized Milwaukee conurbation to the string of cities culminating in Chicago and its suburbs, and terminating at the head of the lake in Gary and Michigan City, Indiana. The urban inhabitants (six million in number) furnish the market for the milk produced in the adjacent dairy regions.

The market milk area lies in the **Dfa-Dfb** (Koeppen) climatic boundary zone, and extends into the main **Dfa** region only in northeastern Illinois. Milk production declines sharply to the west of northeastern Illinois, where a Corn Belt style of agriculture replaces the dairy type.

The market milk region of southeastern Wisconsin and northeastern Illinois only in general follows theoretical locations of where such a bulky product should be produced with respect to any single city market. In fact, the shape and pattern of the milk-shed differs radically from theoretical considerations. The Chicago milk-shed, in particular, is most asymmetrical in shape. It extends northwestward from the city in funnel-fashion to those sections in southeastern Wisconsin which possess a dairy agriculture, and

avoids the Corn Belt and Cash-Grain districts of the Illinois prairies south, southwest, and west of the city.

The main Chicago market milk area northwest of the city is one to which the urban market expanded as the urban center grew. It formerly was a region of creameries and cheese factories,—a going dairy area in the nineteenth century. Diversion of this milk from local factories to a fluid supply was accomplished at the start of the present century,—a case of expanding urban needs being met by the tapping of an existing dairy region, first in northeastern Illinois, later in southeastern Wisconsin. Continued resistance of the Illinois Corn Belt farmers to the dairy industry—partly conditioned by the natural environment of their area—has resulted in additional expansion to outlying dairy lands of Wisconsin, helping further to emphasize the asymmetrical shape of the milk-shed, and further to concentrate the market milk areas in the **Dfa-Dfb** climatic margin regions, and even to carry the fluid milk area far into the Short Summer phase of the Humid Continental Climate, where the city dairy companies compete with manufactural establishments (creameries, condenseries, cheese factories) for their milk supply.

Within the fluid milk area of northeastern Illinois and southeastern Wisconsin the close relationship between rural region and generally adjacent urban markets of the Lake Michigan shore cities is attested to by many observable landscape features, and daily circulation on the highways.

Otis W. Freeman.

Geography of Lake Chelan.

Lake Chelan extends 60 miles into the Cascade Mountains. It averages one to two miles wide and peaks rise 7,000 feet from the surface within three miles, so that the canyon is one of the deepest in North America. During the glacial period an ice stream nearly a mile thick plowed down the Chelan Valley, only the highest peaks and ridges escaping erosion. The Chelan Glacier was fed from a large collecting area and probably attained the greatest extent of any glacier in the Cascade Mountains. The bed rock is predominantly granite. Yet the glacier eroded the valley 410 feet below sea level. Apparently this depth is the result of glacial erosion and not earth movements, since terraces developed at higher levels of Lake Chelan are parallel to the lake surface. The size of the lake results from fluvial-glacial deposits across the Chelan Valley just above its junction with the Columbia River. They forced the outlet to the south side of the valley, over hard granite into which the river has carved a gorge, dropping 450 feet in about two miles. A dam controls the outlet of Lake Chelan and raised the level 21 feet, and water is carried through a tunnel to a power plant at the canyon mouth where 64,400 horsepower is developed.

The dam was formed by deposits from the Cordilleran Ice Sheet that moved southward in the Okanogan and Columbia Valleys to slightly beyond the mouth of Chelan Valley. At one time a lake existed between the ice barrier and the front of the Chelan Glacier, and this lake rose until it overflowed, first through Navarre Coulee and later through Knapp Coulee, south to the Columbia. The lower end of Lake Chelan, especially the gravel terraces and Wapato Point, is devoted to orchards of apples and other fruits, irrigated by pumping from Lake Chelan and other sources. Beyond the narrows little level land exists except at the head of the lake where the Stehekin River has deposited a delta, and at Twenty-five Mile Creek, the last farmed locality reached by highway. The resorts and cabins of tourists on the upper lake are on torrential fans built into the lake. Minerals occur, especially copper and gold, the largest development being at Holden, twelve miles from the lake and 2,500 feet above it, where 300 men are employed in the mine and mill, producing concentrates to be shipped to the Tacoma smelter. The region has been proposed as a national park, but many residents oppose this lest mineral development and economic advancement be limited. A highway runs up the Stehekin Valley 18 miles to Bridge Creek and Horseshoe Basin but the head of the lake has access only by boat and trails.

JOHN W. FREY.

The World's Oil.

Petroleum up to the period of the World War was essentially a convenience, but the fuel oil and motor fuel demand incident to the adoption of oil-burning by navies and the rapid growth of motor traffic made it a necessity to practically every nation. Like other minerals it is a geologic consummation and its occurrence in populous areas is fortuitous; this situation has made national problems, the solution of which has been attacked differently even under similar supply and demand conditions. Large areas such as Australia and Africa are virtually without production and Japan, the largest consumer in Asia, produces only a small fraction of its demand. Europe is next to the United States in consumption but produces only 13% of the world's total. The two surplus producers of Europe are Russia and Roumania; all the other countries are wholly or largely dependent upon imports. The oil-producing countries of South America, except Argentina, are heavy exporters developed by international oil companies through enormous expenditures in search and development. The United States, which produces about 60% and consumes over 50% of the world's oil, has a social and economic superstructure based largely on oil, hence the necessity for conservation and wise use. Conservation efforts in the past have been hit-

and-miss but the problem is of such magnitude as to demand national coordination.

ROBERT M. GLENDINNING.

The Role of Death Valley.

The dry Death Valley trench stands in sharp contrast to the humid and irrigated valleys of California. This is true in both general appearance and in nature and degree of utilization. Yet, Death Valley has achieved one type of use-value; a type based, strangely enough, on the very factors which have so far precluded *permanent* settlement by any but a small and variable number of persons. This value is an outgrowth of an extremely varied, and in some ways unique, physical expression; a physical expression which now annually attracts some 60,000 visitors and a yearly income of about one-third of a million dollars. This has come about chiefly since 1926. As this modern use-value has been achieved there has been a change in the geographical expression of the valley itself; but, perhaps more important, this change has been accompanied by an elaboration of the settlement pattern in large contiguous areas. This elaboration is conspicuous in the matter of the creation and extension of modern highways and their associated services. As a result Death Valley is now playing a recognizably important role in the present settlement expression of the dry areas of the Southwest.

OTTO E. GUTHE.

Some Considerations of the Role of Land Use in Flood Control.

Interest in upstream flood control has recently focused attention upon the degree to which land-use practices can be expected to reduce floods and attendant economic losses. Methods used by the Climatic and Physiographic Division of the Soil Conservation Service in conducting climatic investigations of soil moisture relations revealed a new approach to the problem of evaluating the effect of land use upon stream flow. This paper centers its discussion on the method developed for calculating soil moisture losses to the air and points out the significance of such losses in their relation to the larger problem.

The Upper Licking Watershed in Ohio had certain advantages for study including fifty well-distributed recording rain gages and considerable diversity of land and land-use conditions. A land-use survey, adapted to the requirements of the study, was conducted in this area during 1938 and 1939 for the purpose of securing data on the changing character of field operations and vegetation cover during the growing season.

Moisture loss by transpiration between storms is computed by applying calculated transpiration rates to current vegetation conditions. Rates of ground evaporation, soil infiltration, and accretion to ground water are also

utilized in the determination of stream flow. If the assigned rates prove valid in application, the effects of different land-use complexes on stream flow can be accurately determined and a quantitative basis will be available for evaluating present and proposed land-use practices of watersheds from the standpoint of flood reduction.

ROBERT B. HALL.

Raw Material Deficiencies and American Regional Dependence.

The United States, with the possible exception of the U.S.S.R., is the most nearly self-sufficient of the great powers. Yet there are serious deficiencies. An analysis of the first and second priority deficiencies upon a regional basis indicates that, popular opinion to the contrary, there is little if any real dependence upon Western Europe, a relatively minor but recently increasing dependence upon South America, and an overwhelming dependence upon the lands west of the Pacific, especially those of Southeastern Asia. American international policy should aim to make the vital sources secure to our trade.

J. SULLIVAN GIBSON. (Introduced by W. Elmer Ekblaw.)

The Western Black Belt—Its Geographic Status.

The Black Belt, generally considered co-extensive with the Selma Chalk crescent spanning south-central Alabama and north-eastern Mississippi, comprises a distinct cultural unit. Narrow cultural transition zones—counterparts of sharp geologic and soil boundaries—lead from the Black Belt to surrounding areas with contrasting physical character, land use practices, and racial composition.

The Black Belt of today reflects a past more renowned than its present, and much of its individuality represents a heritage from better days. An agrarian economy rooted in scattered, rolling tracts of prairie soils of unusual pristine richness gave distinction to early society. Slave labor yielded profits to a sparse white population. In early post-slavery decades, a tenant system supplanting the older order perpetuated the prestige of the cotton planter. More recently, soil deterioration and the accompanying exodus of white farmers resulted in economic and cultural decline.

Towns and villages contain only about one-sixth of the total population. Several old towns antedate the railroads and doubtless influenced rail courses; younger towns have grown up along the rail routes. Thus, the urban alignment conforms closely to the rail pattern. Old river towns at present realize little from their advantageous location of a century ago. Farm population comprises the rural element, varying in density somewhat with agricultural affluence.

A definite bi-racial problem underlies the economic and social order of the Black Belt. Nowhere in the South does a sharper color line exist, and nowhere do whites depend more upon blacks. Servant and tenant roles give the negro a degree of economic security, although his lot is a lowly one. Negroes outnumber whites nearly four to one in the western Black Belt. White proportions ranging from one-fourth to one-half in urban centers reflect the absentee-landlord role of white farm owners, and the tendency of white people toward business and professional pursuits.

Negroes perform most of the farm work in the Black Belt. Tenant and share-cropper groups include the majority. Cotton and corn, under small-scale, crude cultivation, yield only moderately except when fertilized. Increased emphasis on beef cattle represents recent trends in some communities.

WALTER HACKER. (Introduced by John Leighly.)

Overloading as a Motor of Mass Movements.

Walther Penck's statement concerning the question implied by the above title reads thus: ". . . for every weight there is a certain minimum slope below which it can no longer migrate downward, and this minimum slope is the greater the smaller the weight resting upon it. . . . If a mass, resting upon a surface whose slope is just below the minimum slope on which movement down slope can take place, experiences an increase of weight, this increase of weight, under all circumstances, produces movement down slope" (*Die morphologische Analyse,* Stuttgart, 1924, p. 69). This statement is in contradiction of an established law of mechanics which states that the maximum slope of an inclined plane on which a body will just remain at rest (angle of repose) is independent of the weight of the body, depending solely on the coefficient of sliding friction. Where mass movements have been observed to follow an increase of load, the movement has been set off by a diminution of the coefficient of friction, probably brought about by the increase of load. But increase of load does not necessarily result in decrease of friction, either logically or actually. It may not change the coefficient at all; and under certain circumstances it may increase friction. In no way can "overloading" be considered a direct cause of mass movements; and it can be an indirect cause only when it causes a reduction of friction. This point has been overlooked by several authors: for example, by C. F. Stewart Sharpe, who lists among "active or initiating causes of landslides" both "overloading" and "reduction of friction" (*Landslides and Related Phenomena,* New York, 1938, p. 85). He thus considered "overloading" by itself not merely a cause of reduction of friction but an active initiating cause of landslides.

RICHARD HARTSHORNE.

The Concepts of "Raison d'être" *and "Maturity" of States; Illustrated from the Mid-Danube Area.*

Any state, to become well established, must present to the populations of its areal parts a distinct *raison d'être,* its justification for existence as an areal unit separate from the neighboring state-areas. This *raison d'être* must be based upon desires or values of first importance to the populations of the regions included in the state. Desires for freedom from war's devastation and for economic advantages are common to all regions, but which of all possible state areas may offer any particular region the best advantages in these respects will depend in part on its particular geographic conditions. The common assumption that larger state-areas necessarily provide greater advantages is not sound. Other values which people expect their states to foster differ in themselves in different regions. These include, notably: religion, language and literature, historic memories, and the form of government. No well-established state bases its *raison d'être* on any one of these; most strive to include all. Since few state areas are homogeneous in all these respects, the problem is to construct a *raison d'être* that will enlist the loyalty of regional groups having different associations and ideals. Although this is difficult where there are linguistic differences, it is much more difficult where different experiences have developed radically different attitudes towards the form of government.

A state is geopolitically *mature* when it has established a *raison d'être* that is so thoroughly accepted by the peoples of all its different regions that they accept without question the inclusion of their regions as integral parts of the state-area. Although time is required to develop a mature state, the process is not analogous to the life-cycle of a biological organism, or to the Davisian physiographic cycle; there are no genetic relationships that lead inevitably from immaturity to maturity, from maturity to old age and death. States may continue immature indefinitely; their immaturity, however, exposes them to greater risks of death than is the case of mature states, however old. The *raison d'être* of a mature state does not remain constant, but must be modified continually to suit new conditions and new concepts. The rate or cessation of territorial growth is entirely independent of maturity or immaturity, excepting that states that have not recognized clearly their *raison d'être* may tend to expand without thought of the resultant increase in immaturity, whereas mature states may hesitate to disrupt their established maturity by expansion, not because of lessened vigor, but because of recognition of the strength that maturity gives.

Various methods are suggested for measuring the factors underlying the maturity of different states and the concepts of *raison d'être* and of maturity

of states are illustrated in terms of the state structure of the Mid-Danube area, before and after the World War.

GEORGE D. HUBBARD.

Major Objectives of Penck and of Davis in Geomorphic Studies.

This paper is directed at Proposition I of a Symposium on W. Penkian *vs.* Davisian Geomorphic Tenets. In this proposition Davis' objective is stated briefly to be the meaning of the cycle in its fullest interpretation. Penck's objective is the discovery of the manner and causes of crustal movements.

These scholars start with somewhat different definitions of Geomorphology and Geography, which may account for their diverse goals. Penck's goal in morphologic analysis is to interpret diastrophism. Davis' goal was to study geomorphology for its own sake and to discover the basis for geography proper as well as to find much interpretation for geologic history. Davis thought of geomorphology as a part of Geography, Penck as a border field between geology and geography.

Penck depends largely on observation; Davis as much on observation but uses much more theory and reasoning. They differ much in their emphasis on different factors. Davis' contribution is the cycle in all its aspects, while Penck's contribution is in the interpretation of forces and manner of crustal movement. The American student will do well to consider both objectives and both methods so as to keep his own balance in his geomorphic studies.

MARK JEFFERSON.

Is Germany a Country? What Is the Test?

There are striking fringes of German speech around Bismarck's Reich. East of the Reich there is a vast area strewn with islands of German speech and what Penck has called German landscapes,—something that leaps to the eye and that other countries lack. Is there a Polish landscape, he asks, or a French one?

These islands of German culture extend across Russia to the Volga. The totality of regions of German speech, German speaking people and German landscape makes up Deutschland. Is Deutschland a country? Was the Reich to which Hitler succeeded in 1934 a country? Is the Reich of November, 1939, a country? Which is Germany? Is there a Germany?

A country is a group of people with feeling of common nationality in their hearts, who accept one government and live on territory that they exploit. The people make a nation and become a country when taken with their territory, but the territory is not their country.

A widespread feeling of common nationality can only be developed out of conflict and compromise of varying local interests so that a country must grow. It is a thing that becomes rather than one that is born or made. A Peace Congress "made" the Kingdom of the Netherlands in 1815. The clash of local feelings made it grow into the kingdom of the Netherlands *and* the Kingdom of Belgium.

When the Versailles treaty attempted to create Czechoslovakia they gave the governors of that cesarean-born babe the task of compromising the strong local feeling of nationality of the Czechs, with that of the Slovaks, and Ruthenians. It was a problem that was created rather than a country. No doubt the leaders did what they could to compromise conflicting local needs. Time was not allowed them sufficient to work up a true national feeling. No one called himself Czechoslovak. The kingdom of the Serbs, Croats and Slovenes was in worse case. An impossible country name aroused no community of feeling in any man. One was Croat, another Serb and another Slovene. As long as men feel hatred instead of toleration for fellow citizens there is no country.

A country is then an ideal to which men may attain by planning as much consideration for all as can be managed. Sense of wrong among some of the citizens is no drawback, if they are allowed to continue to seek redress under the laws.

Suppression of all opposition under Hitler's regime makes the Reich no country. Bismarck's Reich was a country, for opposition parties could make their voices heard and had influence.

HAROLD S. KEMP.

Mussolini—"Geographer."

Mussolini, politician, economist and psychologist, is also a geographer. His government, national business schemes and the handling of his countrymen are securely based on Italian and related geography, not on mere bullying, fantastic aspirations and ruthless taxation. Herein lies his continued and continuing success as a dictator.

At home he has appraised the Italian resources and techniques and found them wanting. At the same time he has appreciated and utilized potentialities in both the land and the people—ridden by outmoded tradition —and has justified his vision of a new nation in a renewed country.

Abroad he has trespassed only where Italy had much to gain and little to lose. He has not taken that which was obvious because at hand, but has added to his national territory contrasted environments. His choice of those environments has not been actuated wholly by greed or vulnerability, but has been so made that, however bitterly other powers may have protested,

he was assured from the start that they would not substitute violent action for diplomatic usage.

Above all, he has dispelled the original antagonism to the dictatorship at home and convinced a highly temperamental people by deeds and concrete gains, that they cannot do better than to follow where he leads. England fights, in Germany, a battle of reason by means of pamphlets. In Italy the dictator has so consistently applied reason to his development of resources, that such a campaign would be folly.

With few exceptions a geographer must applaud Mussolini's reasoning. The man is thus unique among contemporary dictators.

HENRY MADISON KENDALL.

Occupance of the Lower Valley of the Semois in Belgium.

In its course through the Belgian Ardennes, the Semois River flows in a deeply entrenched and irregularly meandering course. The land is still largely forested. Valley flats, abandoned meander channels, and junctions of tributaries with the main stream are sites of settlement. Fourteen villages are spaced irregularly along the river and contain all of the population of the valley. The total population has declined pronouncedly during the past century. Formerly, generalized farming supplemented by use of forest and stream resources provided the basis of settlement; this has changed to specialized tobacco production augmented by tourist trade. Poor transportation facilities have not greatly hindered agricultural specialization and have actually enhanced the recreational value of the valley.

GEORGE KISS. (Introduced by Robert B. Hall.)

The Situation of Budapest.

Budapest, capital of Hungary, had a population of 300,000 in 1873, year of the union of the twin cities Buda and Pest, on both sides of the Danube. In 1930, in spite of the difficulties arising from the treaty of peace, in spite of the fact that the city was within 30 miles of the frontier of the new state, its population came to exceed one million, and the greater city area houses to-day more than 1,500,000 people. This tremendous growth had its origin in the geographical situation of the city, natural center of the Hungarian basin, focus of routes since early Roman times, converging point of great international railroads and highways, economic and cultural center of the great system of plains and plateaus surrounded by the Carpathians.

GENIEVE LAMSON. (Introduced by Helen M. Strong.)

The Poughkeepsie Water Front.

From the first settlement in Poughkeepsie to the present time, the water

front has maintained its importance in the development of the city. Poughkeepsie did not suffer the decline that overtook neighboring river towns, because of a combination of factors, chief of which is its position. Located midway between New York and Albany, the river-line paralleled on the terrace by the Post Road, with valley routes reaching into the rich agricultural land of Dutchess County and western New England, the region includes crossroads over which the grain and cattle of the interland moved to the water front. Numerous streams furnished power sites, and local supplies of lumber and iron ore contributed to industrial development.

The general aspect of the water front is one of ruggedness, with abrupt cliffs, the Hudson River pelite, rising to heights of 60, 80, and 100 feet. Between the rock outcrops the narrow flats allowed for dock and mill sites, and the more gradual slopes for roadways leading to the broad terrace on which the city has spread out.

The sailboat, steamboat, and railroad periods were accompanied by related industrial developments. The first major activity came with the building of frigates and rafts during the Revolution. Local business was stimulated, mills were built at several landings, and regular ferry service to the west shore was established.

After the Revolution, with the beginning of the steamboat era, Poughkeepsie became a great shipping point for grain, flour, beef and pork. Regular steamer service to New York was established. The opening of the Erie canal caused a decline in the commerce of the water front, and other enterprises assumed importance. A whaling industry flourished for twelve years, followed by an active ship-building business. Iron smelting and foundry industries, a tannery, dye-woods factory, and glass factory, were among the industries preceding and continuing into the railroad era.

The opening of the Hudson River Railroad (New York Central), in 1850, and the Railroad bridge in 1888, marked a decline in shipping. The railroad changed the layout of the water front. Many buildings were razed to make way for the tracks.

The present day utilization of the water front continues to reflect the advantage of the location for drawing on outside supplies, and the abundant resources of the hinterland. A large lumber yard, a gas and electric plant, a piano factory, a separator plant, ferry, and Hudson River Day Line docks, occupy the former factory sites and landings.

These industrial plants, the Railroad and Mid-Hudson bridges and New York Central tracks, maintain in modern terms, the combination of industrial and transportation facilities that marked the early use of the water front.

JOHN LEIGHLY.

The Effects of the Great Lakes on the Annual March of Temperature in Their Vicinity.

The annual march of temperature at about 400 stations in the northern United States and in Canada is analyzed with reference to the following elements: (1) mean rise in temperature from the middle of April to the middle of May; (2) mean daily temperature at the maximum of the annual march; (3) date of the maximum of the annual march expressed as delay after the summer solstice; (4) mean fall in temperature from the middle of October to the middle of November; (5) mean daily temperature at the minimum of the annual march; (6) date of the minimum of the annual march expressed as delay after the winter solstice; and (7) annual range of mean daily temperature.

All these elements are mapped by means of isarithms over an area extending far enough from the lakes to get away from their influence. An estimate is made, by interpolating isarithms between the areas beyond the influence of the lakes, of the fields of the several elements as they would exist if the lakes were not present. By subtracting these undisturbed fields of distribution of the several elements from their actual fields, fields of differences are obtained that are also presented in maps of isarithms. These maps represent directly the effects of the lakes.

It appears from the maps last mentioned that (1) the thermal influences of the lakes are stronger in winter than in summer; (2) that the individual lakes exert thermal influences roughly proportional to their respective depths and areas; and (3) that the turbulence field of wind circulation over the lakes, that distributes their thermal effects, is moderately unsymmetrical, with a slight excess of transport toward the east.

JOHN LEIGHLY.

Environmentalism in the History of Thought.

The doctrine of environmentalism represents an effort to carry over to cultural phenomena the principle of causality developed and successfully applied to phenomena of the physical world. Because history is the scholarly field that until recent times concerned itself primarily with social phenomena, the environmentalistic doctrine has generally been directed toward the events that history has recorded. This doctrine has therefore appeared mainly as a theory of history, competing with other theories of historical causation. Apparently it has been particularly prominent at junctures in the history of western thought at moments when the principle of physical causation has enjoyed high esteem. Thus after Greek antiquity, when the doctrine arose parallel with the principle of physical causation, environmentalism enjoyed

a resurgence in the eighteenth century following the triumphs of Newtonian mechanics, and again in the nineteenth century following the successful extension of natural science into the organic and into new parts of the inorganic realm.

As historians have receded from a position that required them to provide a mechanism for "explaining" their accounts of the past, they have ceased to feel a need for any "theory of history." Sociology, as a self-conscious discipline, has also receded from the position Herbert Spencer gave it, that required it to be a necessarily rational physics of society. At the end of the nineteenth century geography was left holding the environmentalistic bag while history, ethnology, and sociology went about other business. In the United States Miss Semple gave the environmentalistic dogma in geography a much more drastic formulation than her teacher Ratzel had given it. Her essentially poetic utterances were obsolete as science when they were announced. They were built on ethnologic theory that was current in the first half of the nineteenth century. At the present time there is no occasion for any conflict among the disciplines concerned with cultural phenomena. Ethnology, history, and sociology have arrived independently at agreement in looking at cultural processes from a phenomenonologic viewpoint, from which human affairs are not expected to display rational causation, but merely a coherence that is to be understood as the product of diffusion of ideas and material objects, tempered with only roughly predictable inventions of new traits.

GEORGE M. MCBRIDE.

The Valley of Panchoy.

Set among the volcanoes of Guatemala, immediately at the foot of Agua and Fuego, this basin is one of the most important as well as one of the most attractive of such "valleys" in the volcanic highland of Central America. From ancient times it has been the site of a numerous population. The Spaniards found several agricultural Indian settlements there. They selected it as the place best suited for their first capital, the Ciudad Vieja. When this was destroyed by flood from the slopes of Volcano Agua (1541), they moved to the other rim of the basin and established the city of Santiago de los Caballeros de Guatemala which served as colonial capital of Central America until the city was destroyed by earthquake in 1773. It was during those centuries one of the most magnificent of the Spanish colonial cities. The seat of government was then transferred across the bordering range of hills northward to its present site, the old city, "Antigua," left in ruins. The Valley of Panchoy, however, continued to be the center of a large population. Its rich alluvial floor has been devoted successively to the native

crops of corn and beans, then to cochineal as well as food crops for the old colonial capital, then, in recent decades to the production of coffee. It has now become also a noted attraction for tourists, its imposing ruins, left almost untouched since 1773 affording the best examples of seventeenth and eighteenth century Spanish colonial architecture still existing. Outlying salient valley-heads still hold Indian communities where life goes on very much as it did before the advent of whites in America.

SHANNON MCCUNE. (Introduced by Samuel Van Valkenburg.)

Climatic Regions of Tyosen (Korea).

Tyosen (Korea) is a land of varied geographic landscapes. This diversity is largely due to the contrasts in the modified continental climate from region to region. Since the winter temperatures govern single or double-crop agriculture systems in Tyosen, they have been used to delineate four climatic provinces which have been subdivided into the following ten climatic regions: A 1, Northern Interior Tyosen; B 2, Northeastern Littoral; C 3, Northern West Tyosen; C 4, Central West Tyosen; C 5, Southern West Tyosen; D 6, South Tyosen; D 7, Southeastern Littoral; D 8, Southern Littoral; D 9, Saisyu Island; and D 10, Uturyo Island. A consideration of the geographic conditions within the climatic regions reveals that part of the diversity of life and landscape in the peninsula is caused by climatic differences from region to region. (A map and four scenes illustrate the paper.)

HOWARD A. MEYERHOFF.

Migration of Erosional Surfaces.

The confusion of current geomorphic interpretation is evident in regional studies where two or more groups of workers are involved. In the Appalachians it is impossible to reconcile the views of Davis, Barrell, and Ashley; in the Rocky Mountains, the views of the Atwoods, Lovering and Van Tuyl, and Rich. Little help has come from the theorists, who seem to believe that all geomorphic principles proceed from a single set of simple premises.

The peneplane concept is one of American geomorphology's most serious liabilities. Conceived as a landform which requires extraordinary tectonic stability for its development, it becomes a static surface with merely ornamental characteristics in upland skylines when the cycle ends and entrenchment ensues. To meet the difficulty of prolonged crustal stability, some workers simply push the date of peneplanation back to a time when geological events are more obscure. Explanation of the Laurentian Upland as a Lipalian peneplane stripped of its Paleozoic sediments is in this category, but it ignores over 1000 feet of relief beneath Cambrian rocks along the southern edge of the upland. Recently such students as Fenneman and

Ashley have questioned the erosional inviolability of raised peneplanes, but they have not given due weight to the requirements of graded-slope equilibrium, or of soil development, which not only inhibits erosion but actually builds up graded surfaces.

Many of these troubles can be resolved by accepting Penck's observations, but divorcing them from his debatable tectonic premises. The retreat of scarps (bösche of Penck and "gravity slope" hereinafter) has been generally noted as a phenomenon independent of fluvial planation in arid regions and in the humid tropics. Its recognition in other climatic situations is essential to further geomorphic progress. The development of graded slopes (haldenhange of Penck and "wash slopes" hereinafter) in interstream areas is recognized as a factor in pedimentation, but it demands recognition as a function of sheet flow and load in all interstream situations. Equally fundamental is the concept of stream gradients as constants determined by volume, with load as a minor variable.

With graded streams as lines of control, wash slopes evolve with respect to receding gravity slopes. The processes of scarp recession and wash slope development proceed in essential equilibrium with the original fluvial controls, even after uplift and entrenchment of the streams occur. Accordingly, wash slopes are mobile forms which are self-perpetuating. Their evolution and geomorphic life are limited only by the extent of ungraded upland, on the one hand, and by the effectiveness of fluvial dissection to lower and later cyclical levels, on the other. Herein lies a demonstrable explanation of persisting erosional surfaces.

HAROLD V. MILLER. (Introduced by G. Donald Hudson.)

Delimitation of Subregions in the Tennessee Valley.

The Tennessee watershed was divided into subregions in order to provide a framework for developing understandings necessary for the comprehensive planning program of the Tennessee Valley Authority.

Aerial mosaics of a scale 1:63,360 were matched together to give a photographic record of the 40,000 odd square miles of the Valley. Boundary lines were sketched directly on the mosaics, supplementing the deductions and interpretations made from the mosaics by reference to land classification data and statistical material. Considerable latitude was allowed in the size and shape of subregions, the intent being to depict actual conditions as they occur.

The first unit completed was Northern Alabama, having about one tenth the Valley's area and nearly a score of subregions. The entire Valley was completed with 45 subregions, demonstrating that essentially homogeneous areas extend across state lines.

The same technique was later applied in dividing the Valley into ten major subregions. These are more generalized, of course, yet they portray the Valley better than would otherwise have been possible considering the small number of units allowed.

The paper deals with the techniques employed; emphasizes the use of aerial mosaics as a tool in geographic investigations; and omits any encyclopedic characterization of the subregions as delimited.

RODERICK PEATTIE.

The Fields of Environmentalism.

The fields of cultural geography and environmentalism are complementary. The factors which are causal in civilization are heredity, environment and human choice. Let these three variables be the dimensions of a cube and all conditions of a culture can be plotted into the cube according to the strength of the three variables. The concept of determinism is possible only when two variables are reduced to zero. The fact would then be plotted in an extreme corner of the cube.

The environmentalistic fields of study which are most profitable are the biological, the historical and the area of regional psychology. This last area is difficult and calls for a special form of scholarship. If environmentalism does not permit easy solution, its controversial character is productive of philosophic depth.

RAFAEL PICÓ. (Introduced by Clarence F. Jones.)

Life in the Karst Country of Northwestern Puerto Rico.

A cross-section through northwestern Puerto Rico, west of the Guajataca River, reveals contrasts in the environment and life within four Tertiary limestone belts. The most northerly, the Quebradillas formation, has given rise to a fairly level, densely peopled section. In the Los Puertos "haystack-hill," sink-hole belt farther south, the large number and closeness of the limestone hills leaves only a few solution plains and sink-holes that could be cultivated or inhabited. The Los Puertos belt is succeeded by the Cibao Lowland, very similar to the Quebradillas topographically, and in the intensive utilization of the land for sugar cane. The southern border of the limestone country is formed by the Lares cliffs and massive haystacks covered by brush and scanty permanent pasture.

The Isabela District, comprising the western extreme of the Quebradillas Lowland, is the leading region in northwestern Puerto Rico. It covers almost half the area (approximately 65 square miles—1.8% of Puerto Rico), and includes about two-thirds of the population. It is a recently elevated coastal plain with a sub-mature topography only slightly dissected by underground solution. Three level lowlands are separated by an east-west trending cuesta and a row of haystack-hills. In the most northerly low-

land the soils are light in texture and are affected by excessive underground drainage. The two interior lowlands comprise less porous soils ranging from loams to clays. Rainfall averages are low, with the exception of the interior and inter-haystack plains, where averages reach slightly over 60 inches. Yet, even here, the permeable soil makes irrigation if not absolutely necessary for food crops, at least convenient for them and essential for sugar cane.

The Isabela Irrigation Service was established in 1927, and has been furnishing water to about 6000 acres, doubling the sugar cane acreage and multiplying by three its production in the Irrigation District. Sugar cane dominates the agricultural economy of the District. Irrigation has not been conducive, as yet, to concentration of the land in a few hands, or to absentee ownership. Medium-sized sugar cane farms predominate. Other commercial crops are tobacco, Sea-Island cotton, and vegetables for the winter market in the United States. The small farms also are important producers of locally consumed food crops such as corn, tropical root-brops, bananas, beans, and peas.

In the Isabela District rural inhabitants per square mile average over 500, one and a half times the mean for all the island. It is the coastal plain area with the highest percentage of pure white inhabitants. In the municipality of Isabela, for example, whites constitute 87% of the total population, while the figure for all Puerto Rico is only 76%. Most of this area was originally settled by immigrants from the Canary Islands. Their ability to do hard work in a meager environment has been shown in agriculture as well as in the handicraft trades: needlework, cigar and chewing-tobacco manufacture, and broom-making.

ERWIN RAISZ. (Introduced by Preston E. James.)

Maps and Charts Showing the Mineral Industry of the United States.

A set of maps and diagrams is presented to show the mineral industry of the United States in a quantitative way, as no such maps are available at the present time. Another purpose of these maps is to test the so-called "block pile" system of statistical mapping. The display includes: (1) the production of the various minerals in 1938 in terms of dollar value; (2) the fluctuations of the industry since 1910; (3) a map of the oil and gas industry; (4) a map of coal production; (5) metallic mineral production in 1938 by value; (6) non-metallic minerals; (7) imports and exports. These maps intend to give a clear conception of the distribution of minerals.

HALLOCK F. RAUP. (Introduced by G. M. McBride.)

The Susquehanna Corridor.

The North Branch of the Susquehanna River provided a trans-Appa-

lachian route between New York City and Buffalo, second in importance only to the Mohawk valley. It was explored and partly settled from *west* of the frontier of white settlement by means of a flanking movement which originated in Connecticut. As a corridor, it has served as a convenient route for Iroquois trails, military roads, a turnpike, a canal, a railway, and modern highways. Its transportation facilities are essential to most human activities between Wilkes-Barre, Pa. and the southern boundary of New York State. Rapid transportation by rail and truck provides for the marketing of one of the principal products of north-central Pennsylvania farms—fresh milk for urban New York. Throughout its history, the corridor feature of the upper Susquehanna has been dominant.

RICHARD JOEL RUSSELL.

Rhone Delta Landscapes.

The geomorphology of the Camargue, or Rhone delta proper, is concerned primarily with the contest between the seaward advance of an alluvial flat and the shoreward advance of the Mediterranean Sea. Marine erosion and regional tilting combine in thwarting the natural result of fluviatile deposition. In most respects the Rhone delta has paralleled, on a greatly reduced scale, the evolution of the Mississippi River delta.

The Rhone delta is rich in historical records which permit very accurate dating of its more recent geomorphological events but a very inadequate supply of sub-surface evidence renders geological conclusions qualitative rather than quantitative. The investigation of nearby areas reveals terracing and structural deformation very similar to that of the hinterland of the Mississippi River delta.

It is the purpose of this paper to report progress in a study made possible by an award from the W. W. Atwood Fund for Studies in Physical Geography. The major physical landscapes of the Rhone Delta and its immediate surroundings will be indicated and briefly described.

I. D. SCOTT AND O. F. EVANS. (Introduced by Preston E. James.)

Breakers—Plunging and Gliding.

Close observation of off-shore breakers shows that not all breakers plunge thereby affecting the off-shore bottom. In many breakers the oversteepening of the front slopes is terminated by a sliding forward of the excess water due to gravity, wind push or shoaling water, or a combination of both. This extraorbital current glides over the opposed upward-backward orbital movement of the preceding trough resulting in opposed currents. This condition causes a turmoil which in turn causes a foaming by which much air is trapped adding to the turmoil. The turmoil is largely confined to the surface layers and seldom affects the bottom as observed by

the authors. Such breakers usually continue for some distance and may advance as foaming crests for long distances where the bottom slope is very gentle. In this case the bottom seems to be affected only by the regular surge of oscillatory wave. It seems then that the excess of energy beyond that required by the true wave form (oscillation or translation) is dissipated in the friction of the opposed motions.

Where off-shore slopes are steep the unsupported crest of the wave plunges forward and downward, striking the bottom almost vertically. A strong turmoil results from this plunge together with trapped air which stirs up sediment and persists in the oncoming trough. Thus material in suspension is moved outward. Such waves often may proceed either as gliding breakers, normal waves of oscillation, or may be converted into waves of translation.

OTIS P. STARKEY. (Introduced by J. Russell Smith.)

Influence of Declining Sugar Prices on Land Utilization in the Lesser Antilles.

The decline of sugar prices which continued from 1875 to 1897 forced West Indian sugar planters to alter their agricultural system. In Montserrat, Dominica, St. Vincent, and Grenada, sugar cane was replaced by more profitable crops. In St. Kitts-Nevis, Antigua, and Barbados, sugar cane proved to be the best cash crop. Consequently the planters in these islands were forced to intensify their agriculture and to increase their efficiency, and thus to compensate for the low prices received. The crisis was most serious in densely populated Barbados and the greatest progress in solving the problem was made there. Under the goad of necessity, Barbadian planters and scientists produced improved varieties of cane and discovered better methods of fertilization and pest control. Larger factories and better method of sugar extraction also increased sugar production. These improvements were copied in Antigua and St. Kitts.

The decline in prices has also forced many of the less efficient estates into bankruptcy. These have been subdivided and sold to the negro peasantry.

HENRY SOMERS STERLING. (Introduced by Vernor C. Finch.)

The Changing Mexican Rancho.

This second report before this Association, on observations in the Valley of Mexico, is based on seven months' fieldwork in the area in 1937 and 1939. It treats of the cumulative changes, physical and functional, which have occurred in the detached farm as a result of the land redistribution attendant upon the present agrarian revolution—a redistribution which is now essentially completed in this sample area.

The dispersed farms of this 2500-square-mile upland basin may be classified into three distinct types on a basis of genesis, form and function. The first two types, the hacienda and rancho, are alike in their emphasis on commercial production, and the fact that they are invariably worked by hired peons. The former great hacienda, with its once imposing residence, farm buildings, and workers' quarters, is usually decadent, abandoned or in ruins now that its land, reduced by expropriation, can no longer support it properly. Medium sized to small ranchos, on the other hand, though hard hit in some cases by expropriation, have multiplied in recent years, especially on the valley floor, through partition of big estates and reclamation of lakebed land. While more modest in appearance, such farms are generally profitable, a fact which is reflected in the better maintenance of their buildings. Still a third type of detached farm, the occasional small one-family rancho, is inconspicuous in the landscape, and has apparently been little affected by the current revolution. Its activities are restricted largely to the production of subsistence crops, and it is worked entirely by its operator and his immediate family.

In addition to causing modification in the form and function of detached estates, land expropriations have also led to certain changes in farm crops and cropping practices. Some crops, such as maguey, have disappeared in parts of the Valley because individual farms no longer have enough of the particular types of land best suited to them. The more intensive land use necessary for profitable operation of reduced acreages has been accompanied by increased concentration upon the crops or products, such as milk, which give the highest yield per unit area.

The commercial farms of the Valley are interspersed with over 500 agricultural villages, in a mosaic of unlike types of occupance. Of all such types, dispersed as well as agglomerated, the newer, small to medium-sized rancho stands out as the most dynamic and prosperous unit of agricultural production.

H. Thompson Straw. (Introduced by K. C. McMurry.)

The Population Distribution and Change in the Eastern Highland Rim Plateau of Tennessee.

The pattern of population distribution, like that of land utilization in this region, is not in harmony with the differences in fertility of the land. Although the majority of the people are farmers they have disregarded the existence of a rich soil belt lying to the east and the infertile "barren" soil belt to the west, and have attached themselves to the major lines of travel. It is here that the small cities and the villages are located and that the areas of denser rural population occur.

This close articulation of population and circulation patterns exists despite the fact that neither the railroads nor the important roads were designed to serve the region but merely to cross it. The Eastern Highland Rim Plateau is a part of a tableland which surrounds the Nashville Basin. With the Cumberland Plateau which lies to the east, it is a barrier area between the two regions of denser population, the Nashville Basin and the East Valley of Tennessee. The circulation pattern of this part of the state was designed to connect these two population centers, not to serve the region it crossed.

It is not alone in the matter of population distribution that this region presents a problem but in the changes in that population which have occurred within the past few years. In a nation where urban migration has been an important phenomenon, a part of a section, the South, which has furnished most of the urban migrants, and a part of a state which has lost about one-fifth of its rural population in the decade 1920 to 1930, this region without large cities has seen an increase in its population. Intra-regional migration has apparently existed but has served merely to reëmphasize the importance of the circulation patterns since the migrants moved to or near the small cities of the region. So little inter-regional migration has existed that the region suffers from overpopulation.

The explanation of this condition seems to lie in the settlement of the region and in what has occurred since. It was settled in the years 1800 to 1830 largely by middle-class farmers who sought to escape the competition of the large plantations of the more fertile Nashville Basin. Since then, low educational standards and poor facilities of transportation have combined to hinder the migration of its people to regions of better opportunity.

Solution of the overpopulation of this region would seem to lie along two lines. First, the encouragement of emigration through the improvement of education and the roads. Secondly, the development of non-farm occupations especially those related to forestry. When the ultimate solution is reached the population distribution will be greatly altered. No longer will it be oriented to a circulation pattern never designed to serve its needs.

GRIFFITH TAYLOR.

Trento to the Reschen Pass—A Cultural Traverse of the Adige Corridor.

The paper commences with a discussion of the significance of the setting of the area, right in the center of the widest part of the European Alps. The Adige leads north to the famous Brenner Pass, but the main stream rises in the Reschen Pass. The latter is nearly as low as the Brenner, but has never been of the same significance. Problems of approach, and of the topography of the valleys, especially of the Inn, are discussed. In the region

concerned there are examples of all three of the usual types of Alpine Pass.

The actual corridor is followed north from Trento. This is a very interesting town, both historically and from the point of view of its adjustment to modern conditions. The role of the Adige in its evolution has varied greatly. Proceeding northward the pattern of several towns and villages and their relation to the topography of the Alpine Trough of the Adige are stressed. The effect of the great alluvial fans at Silandro and Malles is pointed out. A large block-diagram of the Reschen Pass shows that this is a typical "valley-divide." A description of the *Swiss* head of the Adige, *i.e.*, the route leading to the Ofen Pass, is given.

The racial and national boundaries in this borderland region are illustrated by maps. It has of course been the meeting ground of Rhaetian and German cultures right through the centuries. In later years the clash between the German and Italian cultures in the Trentino has been marked. The paper closes with the discussion of a graph showing the relation between crops and elevation as one ascends from 600 feet at Trento to 7000 feet at the Ofen Pass.

JAMES THORP, ROBERT L. PENDLETON and MARK BALDWIN. (Introduced by Charles E. Kellogg.)

Laterite in Relation to Soils of the Tropics.

Temperature, effective moisture, vegetation type, and time determine the general type of soil profile that will develop from most rocks. Speaking very generally, temperature varies with latitude and altitude; effective moisture is determined by rainfall, evaporation rate, and relief. The "age" of a soil of a humid region usually is determined by its physiographic status, since peneplaned areas induce at least a periodically high water table and concurrently keep erosion at a minimum. If the water table varies from high to low with seasonal rainfall on flat land where no new materials are accumulating, soils eventually will become senescent.

Zonal soils develop on moderate slopes and on pervious well-drained materials; intrazonal soils develop on nearly flat land under restricted drainage, or on special rocks, as quartz sands, siliceous shales, and marly limestone; azonal soils occur on steep slopes with rapid geological erosion or as fresh deposits. A geographic association of zonal, intrazonal and azonal soils developed from one kind of material under one general type of vegetation and climate is known as a catena. Some soil associations of both the tropics and temperate regions are catenary and some are noncatenary.

Soils of the tropics are more varied in character than those of temperate zones. "Laterite soils" of Marbut and the "laterite" of Buchanan ("Groundwater laterite" soils of Marbut) represent only two of many great soil

groups of the tropics. The original laterite described by Buchanan is a product of rock weathering that consists of reticulately mottled or vermiculate clays of red, rust-brown, yellow and very light gray colors with a pattern resembling that of slag or of a sponge. It hardens to stone on exposure to air. It underlies strongly bleached or "podzolized" lighter-textured material which varies in color from dirty white to light reddish brown, and in thickness from a few inches to two or three feet. Normally the reaction is very strongly acid. Materials of this type, where exposed at the surface by erosion, have been called "laterite crust." Buchanan's type of "laterite" has developed from a large variety of rocks in tectonically stable (usually peneplaned) regions where soils are periodically saturated and dried out during wet and dry seasons, and where practically no fresh minerals or alluvial materials are being deposited.

"Vermiculate clays" that resemble Buchanan's laterite in color pattern but do not harden to stone when exposed may represent a stage of laterization. In these, laterization may or may not be carried to completion. Materials of this type underlie and apparently are the parent materials of representatives of several of the great soil groups of warm regions.

Characteristics, environments, and agricultural suitabilities of the known great soil groups of warm regions are briefly outlined.

GLENN T. TREWARTHA.

Types of Rural Settlement in Colonial America.

Within the Atlantic Seaboard colonies there were represented in relatively pure form the two extremes in rural settlement—(1) the compact agricultural village, and (2) the isolated farmstead. Seventeenth century New England, exemplifying the former type, was described by Edmund Burke as "a mosaic of little village republics." Virginia and the other planter colonies of the South almost equally well represented the dispersed variety. In the Middle Colonies, intermediate in location, the types were intermingled to a larger degree, although isolated farmsteads predominated.

The settlement type and land system of the Southern and Middle Colonies had an institutional and legal background different from that of New England. The former was based upon the proprietary grant with associated strong commercial motives; the latter upon the town grant where community rather than individual interests were to the forefront. From almost the beginning of settlement in the South, speculation in land, and its granting and sale to individuals, were an integral part of the scheme of colonization. The early rise of great staple crops like tobacco, indigo and rice tended only to intensify the commercial spirit of the enterprise. I do not discount the Indian menace as an influence favoring community settlement in New England, and in the other colonies as well. My contention

is that where land speculation and individualism were strong, economic motives frequently outweighed the item of defense.

EUGENE VAN CLEEF.

Hinterlands of the Eastern Baltic Ports.

European conflicts of recent years have focused world attention more than ever upon the problem of finding a way to establish international boundaries that will not give rise to clashes between neighboring nations. This paper presents the thesis that although greater international stability could be secured through a reduction in number of boundaries, more satisfactory boundaries could be laid down for the small national units whose existence is insisted upon, if port hinterlands were given careful consideration. Port hinterlands of the Eastern Baltic are delineated in principle and discussed in relation to the current eastern European struggle.

WILLIAM VAN ROYEN. (Introduced by Nels A. Bengtson.)

Land Utilization in the Dominican Republic.

Density of population in the Dominican Republic is one-fourth of that of Haiti and one-sixth of that of Puerto Rico. At present the Republic is definitely underpopulated, and would gladly welcome agricultural immigrants with sufficient capital, especially if they should be white. A considerable portion of the country, however, has slopes too steep for agricultural development. Parts of the mountain areas should remain in forest. Efficient watershed protection is necessary in the interest of irrigation. In the pine forests of the Cordillera Central grazing should be strictly controlled.

Where topography does not limit farming, precipitation is the principal factor determining agricultural possibilities. The distribution of rainfall is very irregular and is insufficiently known. The only detailed data on land use in the country are those of the Census of 1935. One-third of the land area is in farms, less than 19% is improved land and only 9% of the area can be considered as tilled land. A cartogram of the percentage of the land in tilled crops shows the highest percentages in the central Cibao, in parts of the Southern Coastal Plain, in the San Cristobal region and near the city of Barahona. Here from 20 to over 40% of the land is in tillage. The maxima are found in the Vega Real. The lowest percentages occur not only in the driest portions of the southwest and northwest, but also in a number of regions with much more favorable climatic conditions. As a result of various conditions the highest percentages of the land in artificial and improved natural pasture are found approximately in the same regions which show the highest amounts of tilled land.

A series of dot maps shows the approximate distribution of the principal commercial crops, sugar, cacao, coffee and tobacco, and that of the main

food crops, plantains and bananas, cassava, rice and corn. The growing of cacao is limited to the northeast by climatic conditions, that of sugar for commercial purposes is limited for economic reasons to the most level and most easily accessible areas. Dry rice is limited by rainfall, and "sawah" rice by the availability of irrigation. However, in all three cases considerable expansion is possible. The food crops mentioned can be grown in all but the driest and highest portions of the Republic, although not everywhere are conditions favorable for production for commercial purposes. Density of rural population is greatest in the Vega Real, with a maximum of 145 per square kilometer in the Moca district. Considerable increases in the density of population are possible in many parts of the Republic.

STEPHEN S. VISHER.

Weather influences on the Yields of Corn, Wheat, Oats and Hay in Indiana, Studied by the Climograph Method.

In a forthcoming volume on the climate of Indiana two chapters are devoted to evidence that crop yields are affected rather consistently by specified weather conditions. Although crop yields depend upon the weather day by day of at least the entire period of growth, and, moreover, several additional factors are important such as quality of seed, soil, and care, nevertheless monthly totals of rainfall and average temperatures also affect crop yields to an extent which is surprising. The departures from the monthly normals are followed by rather consistent variations in yield. The data used in the studies here summarized are the average Indiana yields for 1887 to 1939 inclusive and the monthly average temperatures and rainfall totals for each of the months of each of the fifty-three years; also studied were the number of days with temperatures above 90°, depth of snowfall, length of growing season, etc. Isopleth climographs for each of the more significant months and groups of months for each of the four crops were shown and the evidence which they present was summarized.

For wheat and oats, Indiana's normal April weather is conducive to good yields; May usually is favorable for hay and June for wheat and corn. Departures from the normal weather in these months are generally followed by sub-average yields. On the other hand, Indiana's January, February and March commonly are cooler and wetter than is most advantageous for wheat; May's normal temperature and rainfall are distinctly less desirable for corn and oats than are those somewhat above average. Both July and August average distinctly drier and hotter than is desirable for corn or oats. Contrary to popular belief, temperatures above 90° are distinctly harmful to corn, as is proven by yields. Corn yields increase rather steadily with summer rainfall and with downward departures from Indiana's normal temperature.

For corn, a warm April is desirable; 19 out of 20 relatively warm Aprils preceded superior yields. Cool wet Mays are rarely followed by good corn yields. Every June which was relatively hot or dry was followed by a distinctly subnormal corn crop. Every exceptionally hot July or August was followed by a low yield as was every one with less than two inches of monthly rainfall. Every midsummer (July and August) which received more than normal rainfall was followed by superior yields.

Corresponding analyses of weather and the yield of wheat, oats and hay were given. In brief, for wheat, Februaries which are drier than normal for Indiana are advantageous, as are warmer Marches, cooler Mays, and winters with about 25 inches of snowfall; for oats relatively cool Mays are advantageous as are comparatively cool and wet Junes and Julys. For hay, relatively warm springs, wet Mays and cool wet Junes are advantageous. The indicated optimum rainfall and temperature for each month for these four crops were given.

O. D. VON ENGELN.

A Particular Case of Knickpunkte.

The valleys of the Finger Lakes of central New York State were occupied at the close of the Pleistocene Age by proglacial lakes that experienced *per saltum* declines in level as lower outlets were made available by retreat of the glacier front.

The Finger Lakes valleys had been overdeepened by ice erosion. Tributary valleys, with axes athwart the direction of the main ice advance, were left hanging 300 feet or more above the present lakes. During interglacial and postglacial time the reinstated water drainage cut gorges in the hanging valley lips. In some instances lines of interglacial and postglacial gorge erosion were in a degree coincident. At other sites deposits made by the last ice advance compelled the cutting of an entirely new gorge into the oversteepened slope leading down from the floor of a tributary valley to the local base levels of the lakes in the main valleys.

The length profiles of such interglacial gorges are interrupted by waterfalls with vertical or steep descents. The rocks are nearly horizontally bedded sandstones and shales. Such alternation is appropriate to the development of cap-rock waterfalls, and this is the interpretation that has cursorily been made. In field instruction it proved difficult to make the demonstration of strong and weak layers convincing to students. The differences in rock strength did not seem adequate for the size or place of occurrence of the falls.

This difficulty is resolved when the theory of knickpunkte is applied. According to this view each fall's site marks a new level of the proglacial lakes. The initial declivity in each instance is that of the oversteepened side of the main valley. The first fall would be at the level of the highest stand

of the lake. During the time of that stand the fall crest would recede, leaving a flat gorge-floor at the temporary base level. Each new outlet for the lake waters caused their level to decline almost instantaneously to the lower altitude and another fall started.

There were at least five marked stands, as indicated by fossil delta levels.

The falls thus started appear to have persisted, and are veritable knickpunkte. Cascadilla Gorge is a type example. Between one fall and the next the characteristic condition is a flat reach. The sections of the gorge walls make clear that there is no variation in strength of layers great enough to have given rise to and maintained falls of such height. The flat reaches should be on conspicuously strong beds, the cap rock for the next lower fall, but are not. Joint planes may have helped preserve the knick. But the knickpunkte appear to have been established and maintained independently of the cap-rock relationship, to which falls in such structure are regularly ascribed.

J. R. WHITAKER.

Sequence and Equilibrium in Destruction and Conservation of Natural Resources.

One of the major problems of the Twentieth Century is the shrinkage of the natural-resource base of communities, regions, and nations. Like many other socio-economic problems, that of counteracting resource depletion and deterioration lies within no one scholarly discipline but transects many fields. Traditionally, geographers meet the problem most directly in dealing with the destructive, preservative, and meliorative effects of man on earth resources, as distributed and differentiated over the earth's surface.

In the comparative study of destructive and conservative resource use—in analyzing different areas for a particular time and a particular area for different times—it has become clear that certain sequences of resource destruction and renewal are repeated with sufficient frequency to justify their identification as types. Moreover, one can also recognize types of equilibrium, *i.e.,* levels at which resource depletion and renewal are in balance. As a preliminary analysis of sequence and equilibrium in this phase of human occupance, a number of types are identified and illustrated, the purpose being not to formulate laws divorced from place or time, but, rather, to systematize and simplify description and to promote the understanding of these geographic facts and of the socio-economic problems to which they are related.

FRANK E. WILLIAMS.

A Memoir of Ray Hughes Whitbeck.

To be published in full in a subsequent issue.

LEONARD S. WILSON. (Introduced by L. M. Gould.)

Settlement Patterns of the Inner Bluegrass of Kentucky.

The Bluegrass of Kentucky has long been accepted as an outstanding example of a geographic unit in which coincidence exists between the natural and cultural landscapes.[1] Actually only a weak coincidence was observed during the summer of 1939.

Bluegrass settlement may be divided into several different types. Of major importance is the extensive holding. Large fields, a comparatively small amount of any particular unit devoted to crops in any given year, and large areas either idle or devoted to stock-farming characterize this as the "Bluegrass Pattern of Settlement." Other smaller holdings approaching subsistence-farming levels are also found within the geological region known as the Inner Bluegrass.

The distribution of the various types of holdings has resulted in obvious field patterns which do not show more than a weak correspondence to the underlying rocks and the residual soils derived from these deposits. In the northern limits of the Lexington and Cynthiana Limestone which underly the Inner Bluegrass the settlement pattern has spread into the adjoining deposits which are supposed to weather into infertile, easily eroded surfaces. In the south, the "Bluegrass Pattern of Settlement" has not occupied the limestone deposits completely.

Explanation for the lack of coincidence may be found in both the cultural and natural landscapes. Proximity to the major urban centers in northern United States has been one of the deciding factors in causing the expansion to adjoining northern lands. Another contributing factor has been the ease of transportation north of Lexington in contrast to that found south of the city. The western limits also show a discordance caused by the Kentucky River which acts as a major barrier to communication with the center of the region. Backed by the maturely eroded Cumberland Plateau, the eastern limit of the Bluegrass suffers from a lack of connections with the cities of the eastern seaboard.

Numerous inlyers of the surrounding shale belt have been submerged beneath the occupance pattern and indicate, together with the lack of coincidence along the limits of the region, that the geological deposits are not of major importance in the distribution of the cultural landscape. In areas which are maturely eroded, subsistence-level farms may be encountered on the same deposits which have theoretically been the site of the "Bluegrass Pattern." This would tend to indicate that transportation and other cultural factors are of more importance than the physical limits in deciding the distribution of the "Bluegrass Pattern of Occupance."

[1] Two examples of the literature are: Davis, D. H., *Geography of the Bluegrass Region.* K.G.S., Lexington, Ky., 1927; and Fenneman, N. M., *Physiography of Eastern United States.* McGraw-Hill, New York, 1938, p. 439.

Exhibits at the Chicago Meeting

The cartographic display filled the large exhibition space in the map hall of the University of Chicago and overflowed to other rooms. A catalog of the showing lies beyond the province of this note. Mention of the types of exhibits may serve to indicate lines of endeavor being pursued by the geographic profession in this country.

Conspicuous in the permanent display in the map hall is a vast relief model of the Mississippi Basin on a scale of 1:75,000, with vertical exaggeration of 20:1, made in 1934 at New York University.

The Department of Geography and the Map Library of the University of Chicago presented a large showing of published maps, both recent and early, depicting land-use mapping in several aspects. Maps by Hayden, Powell, Wheeler, and Gannett proved that land-use maps were made early in the geographic study of the United States. These, together with later work, covered minerals, soils, forests, farmlands, and herd ranges. Other series dealt, some with submarginal lands, others with watershed areas, and still others with examples of regional land use. Cases of urban and rural land use from every continent, save South America and Australia, were supplemented by aerial photographs showing typical views of all the land-use regions of the United States.

Complementary to these published maps, was a roomful of manuscript maps demonstrating the use made by students of the materials of the Map Library.

A series of maps showing traffic flow illustrated a phase of applied geography intimately related to land use.

Another historical exhibit consisted of photostats of maps of the North American continent from the beginning of its cartographic representation. This was prepared for a series of American History maps of Rand McNally and Co., and was presented apart from the commercial exhibits of map-making firms, which were housed elsewhere.

Several departments of the federal government were amply represented. Of these displays two were large. The Soil Conservation Service presented the abundant and varied matter which carries its program of information to the general public. Maps and graphs which hung on the walls were supplemented by pamphlets and books placed on tables. Other output of this Service included soil-erosion and drouth-expectancy maps. The Federal W.P.A. and the Massachusetts Department of Public Works jointly presented a demonstration of geodetic procedure, using the Boston area as its example.

A novelty was a demonstration of the stereo-plotting instrument being used by the United States Geological Survey for making topographic maps. It, and the accompanying exhibit of maps, illustrated aspects of the Presidential Address (pp. 1–24).

Akin to this exhibit was a series of multi-lens aerial photographs showing the use of 3, 4, 5, and 9 lenses.

Several individuals hung manuscript maps which they used to illustrate their papers, and a few maps were shown which were not represented on the platform.